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J. K. Couchman J. C. MacBean A. Stecher D. F. Wentworth

Mini-climates

Examining Your Environment

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Examining Your Environment

MINI-CLIMATES

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The Metric Commission has
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Symbol for Metric Conversion.

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Introduction

In *Mini-climates* you will be studying small areas outside the school. These areas may include the school lawn, the sand pit, a tree, a ditch or even something as tiny as an ant hill. The scientific name for this study is microclimatology. When a scientist studies a microclimate he examines in a small area such things as the weather conditions (meteorology), soil, plant and animal life, and the ways in which all of these inter-relate (ecology). You will be able to carry out the same type of investigations. Much of your work will require that you carefully collect data or information from which you can form a logical answer to a problem. Some of your best data will come from using a number of simple measuring devices that you, in many cases, will be able to make yourself.

Do not feel that you must do all of the activities in this book. The equipment and time available will likely influence what you will do. You may decide to study deeply the problems in only one chapter. This is much better than jumping lightly from one investigation to another.

Mini-climates helps to point out to you some of the interesting problems that are awaiting your investigation in your school or home neighbourhood. As you work on these problems you may discover other problems that you want to investigate. Your problems may be much better than those suggested by the authors. Don't be afraid to investigate them.

As you carry out these investigations you will find that, more and more, you must rely upon the information that you have collected to provide answers to your problems. The answers are not available in books. If you do your activities carefully and repeat them to obtain evidence that can be averaged, you will usually arrive at reasonable answers. Learn to trust your own senses.

Pronunciation Guide

a, like *a* in b*a*t
ah, like *a* in c*a*lm
ai, like *ai* in p*ai*r
ay, like *a* in b*a*ke
aw, like *aw* in l*aw*
e, eh, like *e* in f*e*d
ea, like *ea* in n*ea*r
ee, like *ee* in d*ee*d
ew, like *ew* in f*ew*
i, uh, like *i* in b*i*n
y, ye, eye, like *i* in m*i*nd
o, like *o* in p*o*t
oo, like *oo* in m*oo*d
oh, like *o* in ph*o*ne
oi, like *oi* in f*oi*l
ow, like *ow* in *ow*l
u, uh, like *u* in b*u*n
er, like *er* in min*er*
ur, like *ure* in nat*ure*
g, like *g* in *g*et
j, like *j* in *j*oy
z, like *s* in her*s*
zh, like *s* in mea*s*ure

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1

TEMPERATURE

IN A MINI-CLIMATE.

2769120

The thermometer should be inserted so that the mailing tube shields the bulb of the thermometer from the direct rays of the sun.

The thermometer should be given sufficient time to settle. This will require at least five minutes.

When reading the temperatures be careful to avoid holding the thermometer by the bulb or exposing the bulb to the rays of the sun. All temperature readings should be taken with a minimum waste of time.

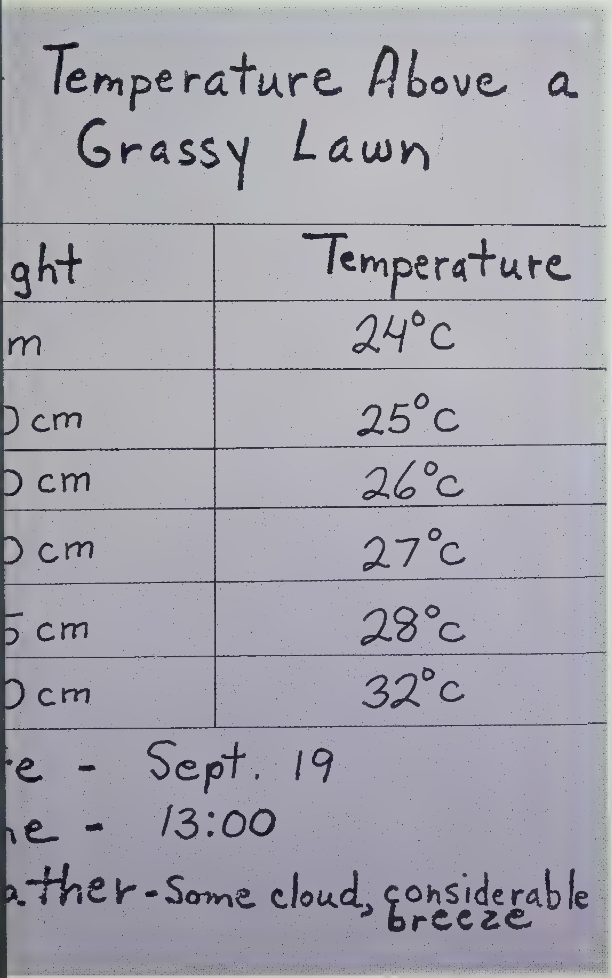
Activity 1:

What temperature differences can be found in the air above the ground surface?

Place the thermometer stand on a clipped grassy lawn on a calm sunny day at about 13:00.

When the thermometers have settled (after about five minutes), record the temperatures.

Display the information in a clear manner.



Temperature Above a Grassy Lawn

ght	Temperature
m	24°C
cm	25°C
cm	26°C
cm	27°C
5 cm	28°C
cm	32°C

e - Sept. 19

e - 13:00

ther - Some cloud, considerable breeze

Digging Deeper

What was the variable in this activity? What do we mean by the word "variable."

What factors were reduced or eliminated by using the thermometer stand?

At what height is the temperature the greatest?

Through what range is the decrease of temperature the greatest?

At what height does the temperature begin to level off?

What might be the temperature at a height of 20 cm? 40 cm? 80 cm?

What might be the temperature at a height of 1.5 m?

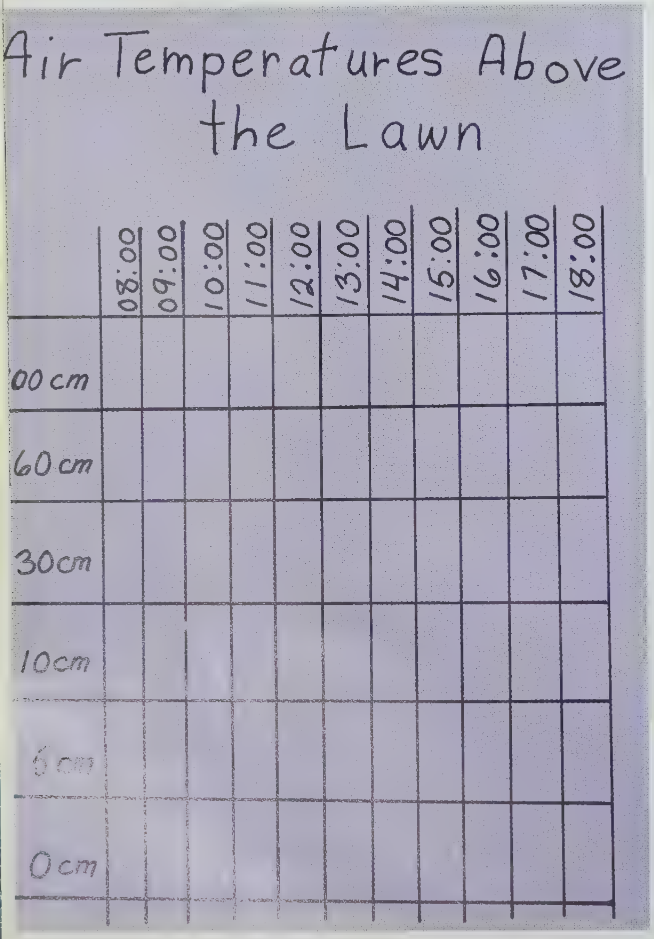
Branching Out

Now that you have learned how to measure the air temperature at different heights above the clipped grassy lawn, you may wish to do further investigations. The following are some activities that can provide much more information about the temperatures above the schoolyard. Again it will be best if a group of pupils plan and carry out an activity. It may be difficult to obtain enough thermometers to investigate each activity at one time. This might affect the variable of time. Try to collect your facts in a reasonably short space of time to reduce the influence of this variable.

If you find that constant breezes seriously affect your readings, you can build a cardboard screen to block out the wind and still permit the sunlight to shine on the foil-wrapped mailing tubes containing the thermometers. Even if used with care, the cardboard screen may provide some misleading information. What problems can you foresee?

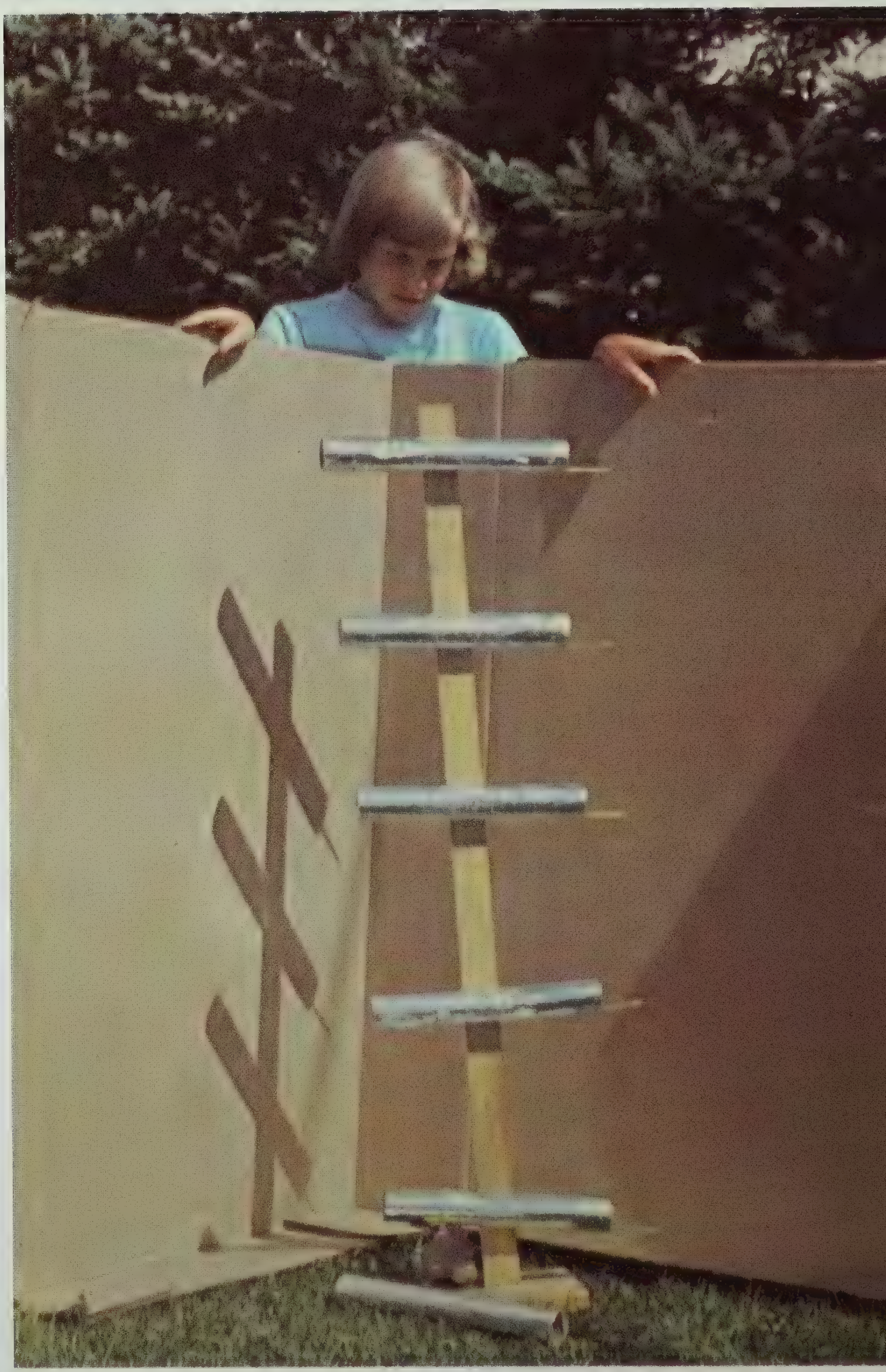
Activity 1 (a):

Repeat Activity 1 but take temperature readings at one-hour intervals starting at 08:00 and continuing for as long as it is practical. What is meant by the word "intervals"?



Air Temperatures Above the Lawn

	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
00 cm											
60 cm											
30cm											
10cm											
5 cm											
0 cm											



The cardboard screen permits the sun to shine on the thermometer stand but blocks the wind. To what extent does the cardboard screen produce the conditions that might be found on a calm day?

Digging Deeper

How does the temperature pattern vary throughout the day?

When was the temperature the highest?

When was the temperature the lowest?

How would you explain the temperature pattern?

What are some of the things that will influence temperature during a day?

Activity 1 (b):

Repeat Activity 1 under the same conditions to measure the temperature of the air above the following: an asphalt playing surface, a meadow with high grass, a sand pit, bare ground, a tree shaded spot, a concrete sidewalk, a small puddle.

Can you suggest some other surfaces near your home or school that might be investigated?

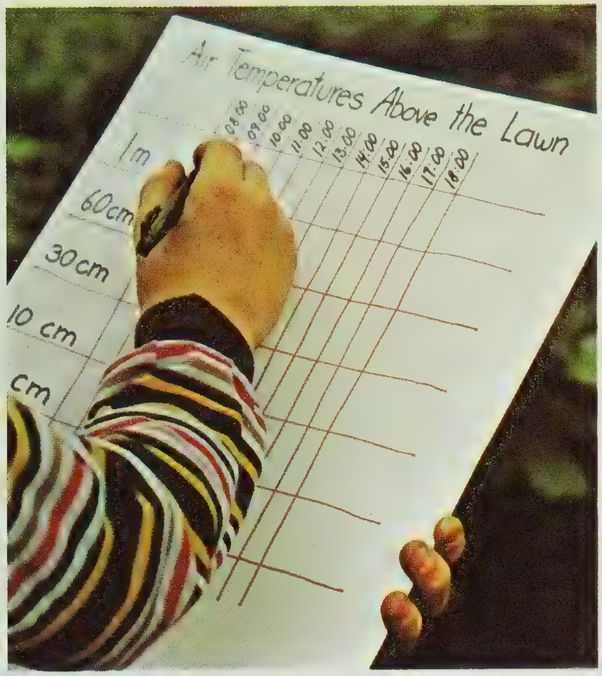
Digging Deeper

How did the air temperatures above the different surfaces vary?

Above what surface did the temperature change the most?

Above what surface did the temperature change the least?

What assumptions or theories can you suggest to explain the differences in the readings? Look in your dictionary or in the glossary to find the meanings of the words "assumption" and "theory."



Activity 1 (c):

Repeat Activity 1 (a) measuring the air temperature above an asphalt playing surface, a meadow with high grass, a sand pit, bare ground, a tree shaded spot, a concrete sidewalk, a small puddle.

Digging Deeper

In each investigation how did the temperature pattern vary?

At what time was the temperature highest?

At what time was the temperature lowest?

At what height above the surface was the temperature highest? lowest?

How would you explain the temperature patterns?

Temperatures Below the Ground Surface

Obtain a 25 cm spike and with a file mark the spike at points 2.5 cm, 5 cm, 10 cm, and 20 cm from the tip. You can make holes for thermometers by driving the spike into the soil. The marks on the spike will make it easy to obtain the correct depths. Place the thermometers into the holes and record the temperatures after allowing about five minutes for the thermometers to settle. It is important, particularly if the activity is carried out in the winter, that the thermometers be allowed to come to the temperature of the air before being placed in the hole. A warm thermometer can easily freeze to the hole. Be careful when removing the thermometers from the holes in order to prevent breakage.

Activity 2:

What temperature differences can be found in the soil beneath a clipped grassy lawn?

With the spike and a hammer punch holes 2.5 cm, 5 cm, 10 cm, and 20 cm into the lawn. Place the holes close to each other.

Set the thermometers in the holes on a sunny day at about 13:00 and record the temperatures.

Show the information in a meaningful manner.

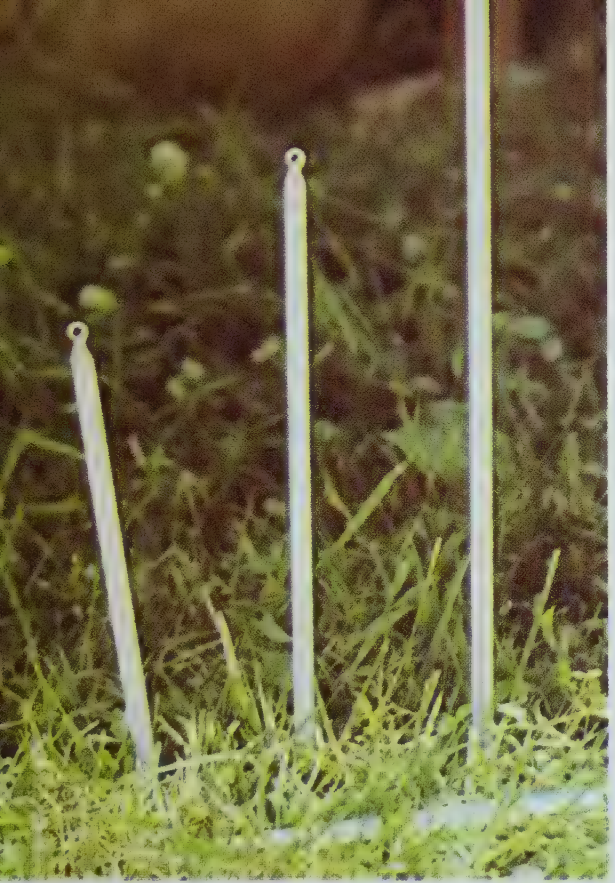
Digging Deeper

What was the variable in this activity?

At what depth is the temperature the greatest?

Through what range is the decrease in temperature the greatest?

The thermometers should be located close to each other so that only the variable of depth will affect the temperature readings.



Care should be taken to prevent shadows from falling on the patch of ground that is being studied.

Try to read the temperatures without removing the thermometers from the ground. Other members of the group should check to be certain that the temperature readings are accurately taken and recorded.

What might be the soil temperature at a depth of 7.5 cm? 15 cm? 2.5 cm?

What might be the soil temperature at a depth of 30 cm? 1.5 cm?

Branching Out

Activity 2 (a):

Repeat Activity 2 but take temperature readings at one-hour intervals starting at 08:00 and continuing for as long as it is practical.

Digging Deeper

How does the temperature pattern vary throughout the day?

When was the temperature the highest?

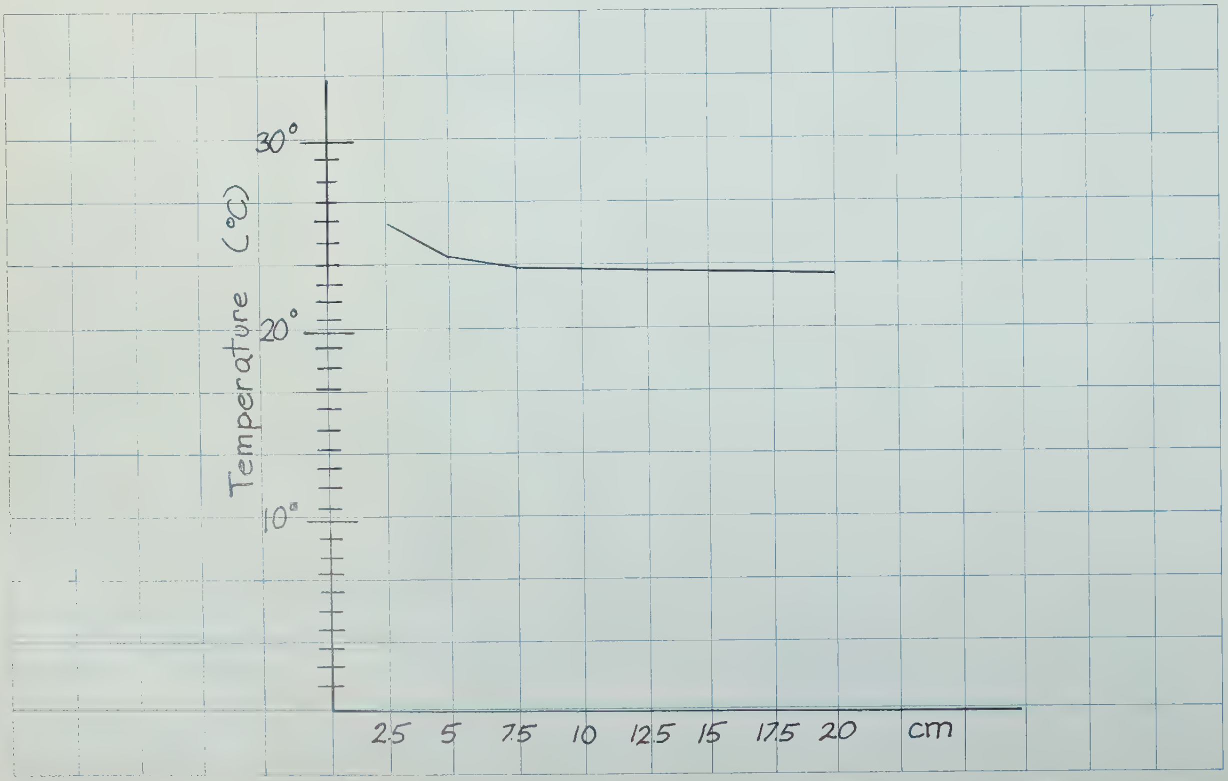
When was the temperature the lowest?

How would you explain the temperature pattern?

Activity 2 (b):

Repeat Activity 2 under the same conditions to measure the soil temperature of each of the following: a bare garden soil, a meadow with high grass, a sand pit, a tree shaded spot, an asphalt area, an area covered with peat moss or forest duff.

What other types of soils near your home or school can you investigate?



Temperature differences beneath a grassy lawn.

Digging Deeper

How did the temperatures in each type of soil vary?

In what soil did the temperature change the most?

In what soil did the temperature change the least?

What assumptions or theories can you suggest to explain the differences in the readings?

Activity 2 (c):

Repeat Activity 2 (a) measuring the soil temperature in bare garden soil, a meadow with high grass, a sand pit, a tree shaded spot, an asphalt area, an area covered with peat moss or forest duff.

Digging Deeper

In each investigation how did the temperature pattern vary?

At what time was the temperature highest? lowest?

At what depth was the temperature highest? lowest?

In what soil did the temperatures change the most? the least?

How would you explain the temperature patterns?

It is interesting to attempt the activities with an asphalt surface, but you may decide not to do them because of the hardness of this material, especially when it is cold.

Temperatures on the Outside Walls of the School Building

As you walked around the school building, you likely noticed that temperatures were different on different sides of the school. Perhaps some sides were sunny and others shady. If you observed very closely, you may even have discovered differences in the soil and plants near the different walls.

In the following activities you will discover some temperature differences that are found on and near the walls of your school. Four thermometers placed in foil-wrapped mailing tubes are required.

Activity 3:

What temperature differences can be found on the outside walls of the school building?

At a height of 100 cm above the ground, tape a foil-wrapped mailing tube containing a thermometer to each of the four outside walls of the school building.

On a sunny calm day record the temperature at one-hour intervals, starting at 08:30.

Display your information in a suitable and easily understood manner.

Digging Deeper

Which wall had the greatest changes in temperature during the day?

On which wall was the temperature mostly the same?

Which wall had high temperatures for the longest period of time?

In which direction would you prefer to have your classroom windows face? Why?

Branching Out

You may wish to continue the study of temperatures on the walls of your school building by investigating the following problems:

Does the kind of material of which the wall is made affect the temperature?

Does the colour of the wall affect the temperature?

Are the temperatures at ground level and at 100 cm above ground the same?

What are the wall temperatures in autumn, winter, spring, summer?

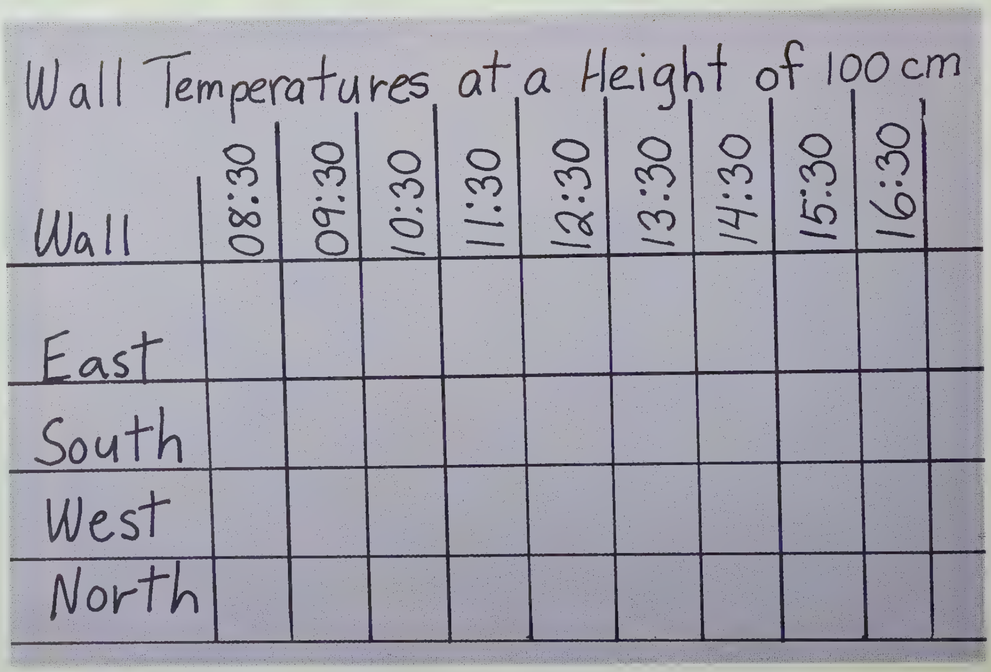
Along which wall does plant life first turn green in the spring?

How different are temperatures on a shady spot and a sunny spot on the same wall?

Where is the frost line in the ground beside each wall?

What relationship can you find between the wall temperatures and the temperature of the soil beside the wall?

Since temperatures on all four walls should be read at the same time it will be necessary that at least four students work together on this activity.



Wall Temperatures at a Height of 100 cm

Wall	08:30	09:30	10:30	11:30	12:30	13:30	14:30	15:30	16:30	
East										
South										
West										
North										

Temperatures and the Slope of the Land

In or near most schoolyards one will find a slight hill or ditch or ravine. Some interesting discoveries about temperatures can be made by using some thermometers placed in foil-wrapped mailing tubes. Again the most significant results will be observed if the readings are taken when the sun is shining brightly. Other readings should also be taken on dull, cloudy days to compare with your first readings.

Activity 4:

How do temperatures vary on the slopes of a shallow ditch?

Find a ditch that runs east and west.

Put a thermometer enclosed in a foil-wrapped mailing tube on each slope of the ditch.

Record the temperature of each thermometer at one-hour intervals.

Display your information in a suitable manner.

Digging Deeper

Which slope had the highest temperatures?

At what time of day was the temperature highest?

Is there any noticeable difference in the plant life of the two slopes?

Branching Out

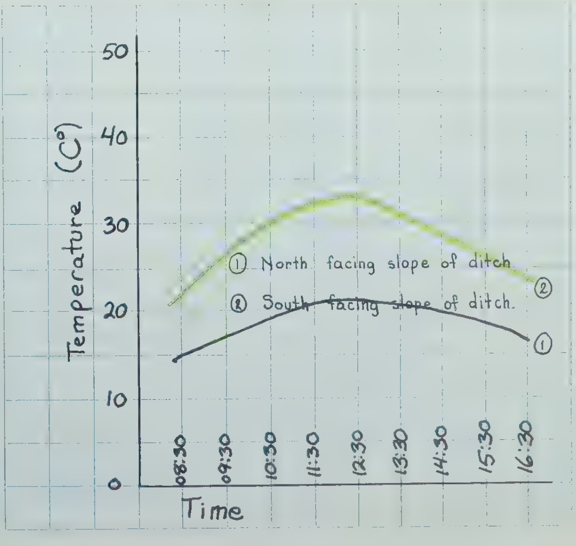
What temperature differences would you find on the slopes of a north-south running ditch?

How do the temperatures on the slope of a hill compare with temperatures on a similar flat area?

What effect has the direction of a slope on temperature?

What effect has the angle of the slope on the temperature?

How does the temperature on a slope change with the seasons of the year?



The thermometers in the ditch are not enclosed in foil wrapped mailing tubes to enable them to be seen more easily. What would the thermometers read if they were left exposed as shown in the picture? How would the readings compare with those obtained from enclosed thermometers?

Temperature and the Colour of the Ground Surface

The difference in colour is one of the most easily noticed differences in surfaces. Even a casual observation of soil will enable you to see such differences as yellow clay, white sand and black loam. If you visit a farm in late summer, you will see a wide range of colour in the fields, from yellow wheat through various shades of green. During the heat of midsummer, many shades of green and brown are noticeable on the school and home lawns. A simple experiment can be done out-of-doors to discover the effect of soil surface colour on temperature.

Activity 5:

How is soil temperature affected by the colour of the soil?

In an open area, such as a garden, mark off, side by side, three plots of ground that are each one metre square. The squares should be as much alike as possible.

Cover plot 1 with an evenly distributed layer of coal dust.

Cover plot 2 evenly with an equal amount of lime.

Leave plot 3 as it is. It will serve as a control plot.

In the centre of each plot place a thermometer, covering the bulb of the thermometer with a thin layer of soil.

Leave the plots undisturbed for a few hours on a sunny day and then read the temperatures.

Digging Deeper

What was the only variable in this experiment?

What temperature differences did you discover?

What assumptions might you make as a result of this experiment?

The plot of ground on the left side is covered with coal dust. The one on the right side is covered with lime. The plot in the centre is the control.

How can you test your assumptions?

How would the temperature readings for each plot compare if taken at one-hour intervals throughout the day?

Branching Out

Many other activities may be carried out to learn the effect of surface colour on temperature. The following are a few problems that you may wish to investigate. What other problems can you discover?

What would be the temperature readings if different colours of tempera powder were sprinkled on similar plots of ground?

How does the temperature of different shades of sand vary?

How would water temperature vary in two similar cans placed in the sunlight if one can is painted black and the other white? What can you find out if cans painted other colours are used?

What are the temperature readings in the different coloured patches in a lawn?

How would temperature readings in a yellow wheat field and green alfalfa hay field compare?

What temperature readings would you obtain if different materials such as leaf litter, forest duff, peat moss and gravel were tested? What variable in addition to colour was present in this activity?

Does snow affect the temperature of soil?

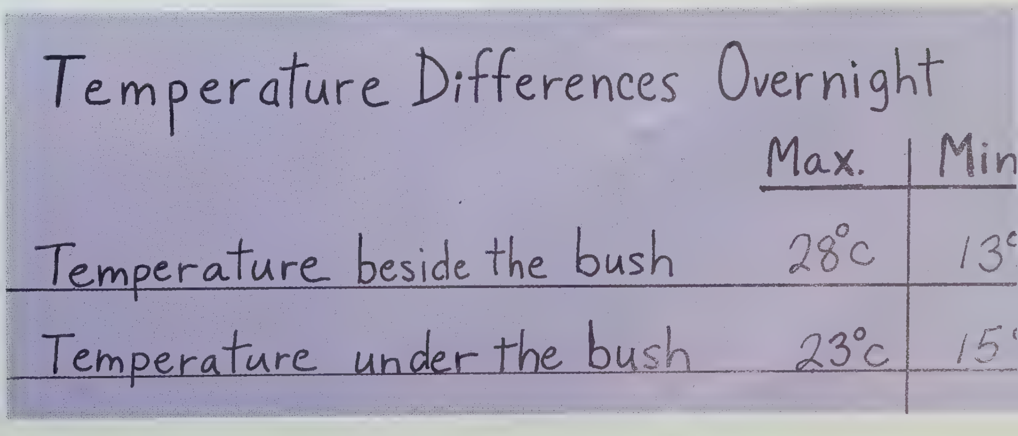
Using Maximum-Minimum Thermometers

A maximum-minimum thermometer is an instrument that allows one to read the highest and the lowest temperatures that were found in a particular place over a period of time. After the readings have been noted, this thermometer can be re-adjusted and used again.

If your school has two or more maximum-minimum thermometers many interesting discoveries can be made. Make comparisons of high and low temperatures in each of the following situations. The maximum-minimum thermometers can be left for a full day (24 h) in each location:

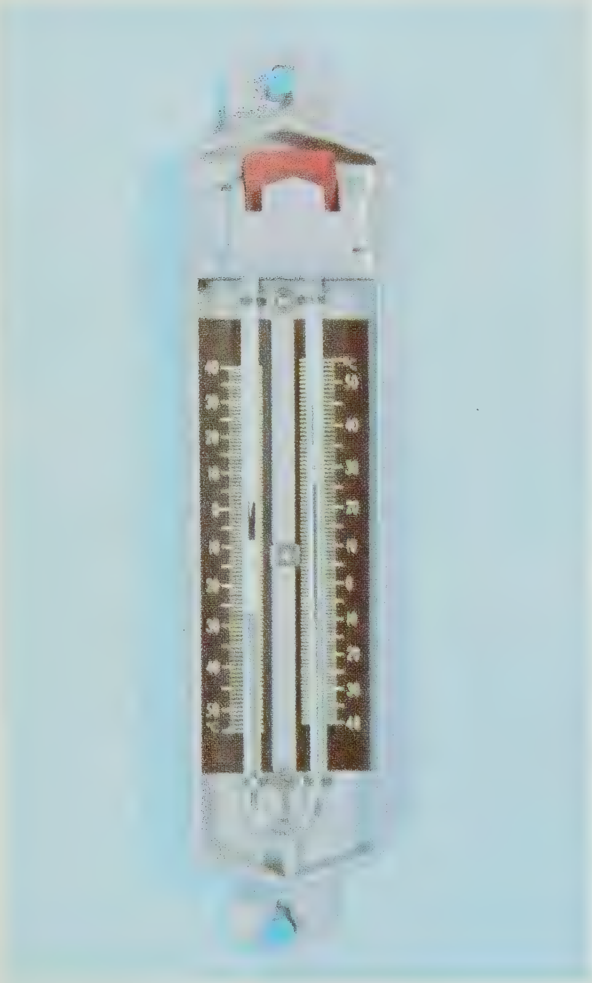
- bottom of a ditch and the side of a ditch
- top of a hill and the bottom of the hill
- bottom of a hole and the top of the hole
- under a shrub and beside the shrub
- inside a groundhog hole and at the entrance to the hole
- on a lawn, 10 cm below the surface.

Use the maximum-minimum thermometers to compare as many different locations as possible. Try to explain the differences that you discover.



Temperature Differences Overnight

	Max.	Min
Temperature beside the bush	28°c	13°
Temperature under the bush	23°c	15°



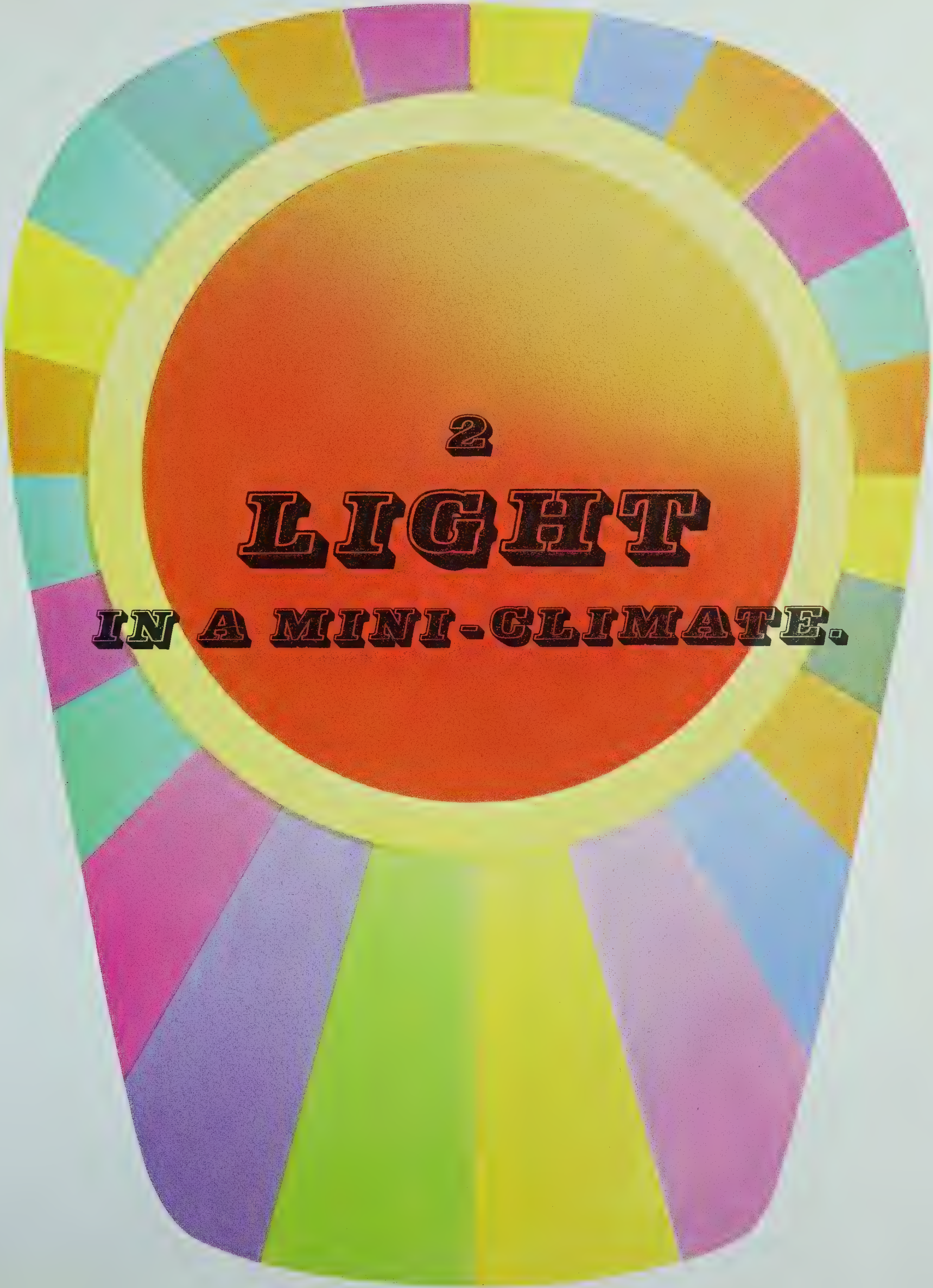
As the temperature gets lower the mercury in the maximum-minimum thermometer rises in the left-hand tube and drops in the right-hand tube. The opposite occurs when the temperature increases. A marker in each of the tubes shows the highest and the lowest temperatures obtained.

The two maximum-minimum thermometers are left outside overnight. One is placed under the bush and the other beside it. Why is it unnecessary to enclose the two maximum-minimum thermometers in foil wrapped mailing tubes?

2

LIGHT

IN A MINI-CLIMATE.



The amount of sunlight shining on a mini-climate is of great importance to the plant and animal life. Plants require sunlight as a source of energy in order to produce plant food. The process by which green plants use sunlight to make plant food from carbon dioxide (KAR·bon dey·ox·eyd) is called photosynthesis (foh·toh·SIN·the·sis). Sunlight strongly affects the behaviour of animals. Some animals are active during the hours of sunlight and others are active at night. Still others find the time between day and night most suitable for activity.

The earlier investigations with the thermometer provided some understanding of the temperature differences in and above the ground. Just as it was possible to measure the temperature in a mini-climate, it is also possible to measure the intensity of the sunlight and the amount of sunlight that is reflected by different surfaces. What is meant by the word "intensity"?

Activity 1:

How does light intensity differ?

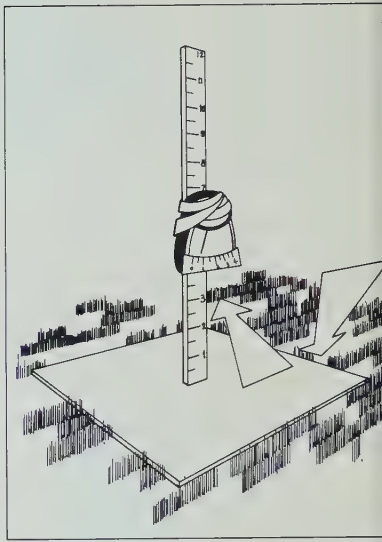
An instrument that measures light intensity is a light meter. This instrument is usually used with a camera when taking photographs. Obtain a light meter and point it at different surfaces such as white paper, the grass, the soil. It is not advisable to point the light meter directly at the sun. Did the needle on the face of the light meter move the same distance each time? What surface caused it to move the greatest distance?

On paper draw a scale like the one shown on the diagram and scotch tape it to the light meter. (If a light meter that measures in lux is used, this step will be unnecessary.)

Fasten the light meter to a 30 cm ruler with masking tape so that the photoelectric cell of the light meter is at the 10 cm mark.

Cut a 30 cm square piece of light grey bristol board.

When the sun is shining brightly, place the bristol board in a number of places such as on the lawn, under a tree, under a bush, on bare soil. At the same time, read the light intensity on your home-made scale while holding the ruler and light meter in a vertical position in the middle of the bristol board. The light intensity in this activity is the amount of light reflected from the bristol board. Record your findings.



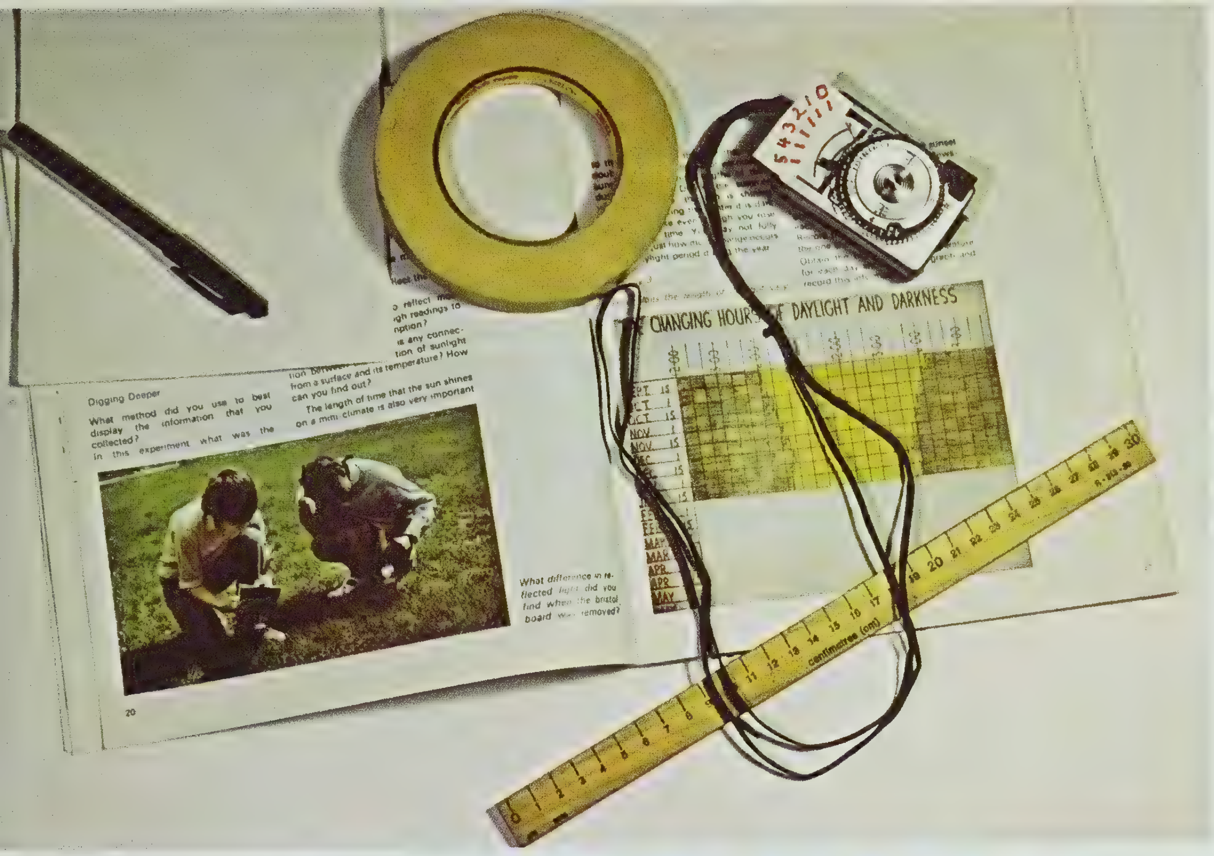
Digging Deeper

In what place was the sunlight most intense? least intense?

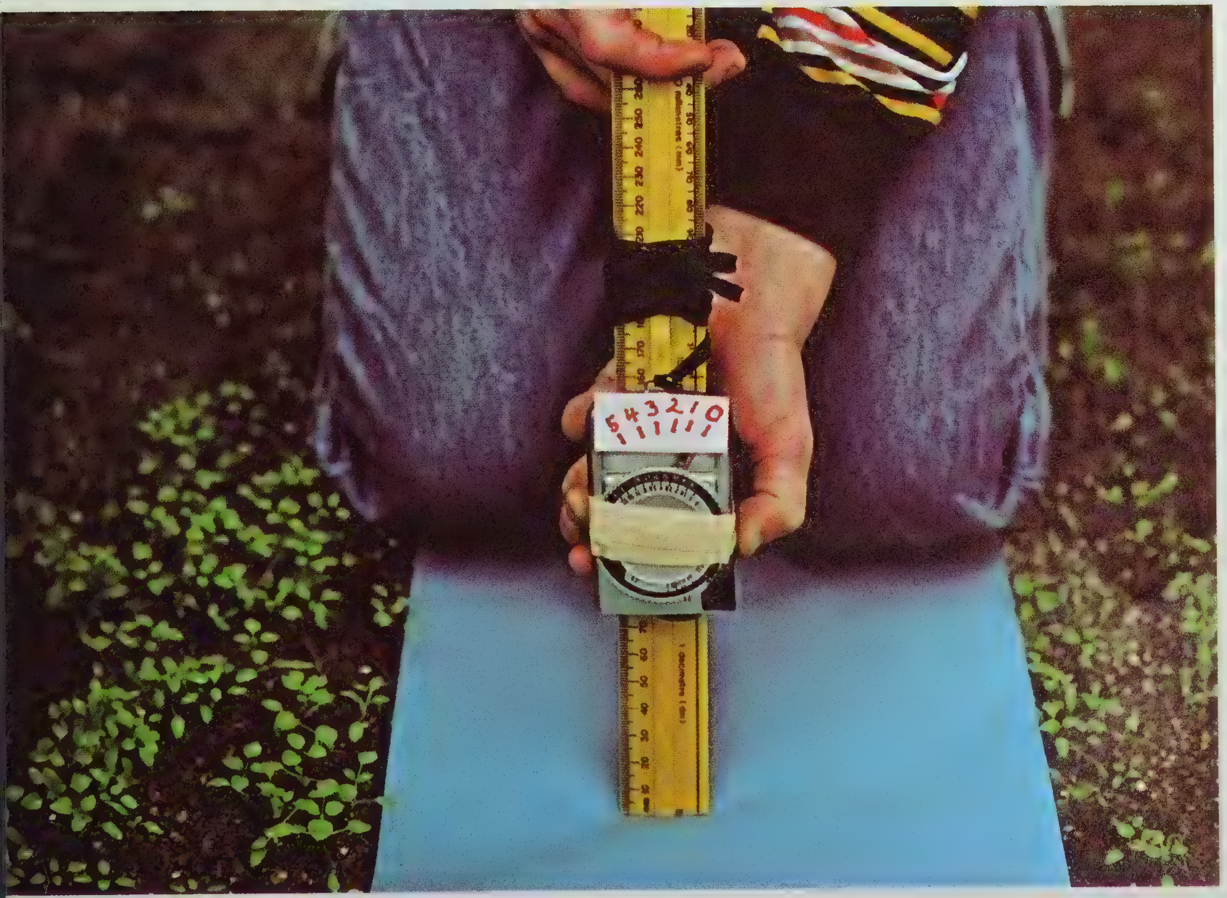
What range of light intensity did you find?

To what extent does the intensity of the sunlight in a particular mini-climate differ on cloudy and sunny days?

How does the light intensity of the sunlight differ in a woodland in winter and summer? How can you find out if your assumption is correct? How are wildflowers affected by the changing amount of sunlight in a woodland?


543210
CHANGING HOURS OF DAYLIGHT AND DARKNESS
Digging Deeper
What method did you use to best display the information that you collected?
In this experiment what was the
What difference in reflected light did you find when the bristol board was removed?
centimetres (cm)

These materials will enable you to make a light measuring device.



Avoid casting a shadow on the surface which is being measured.

Activity 2:

How much sunlight is reflected by different surfaces?

Repeat the previous activity and record the light intensity at each place. Before moving on to another location, remove the bristol board and record the light intensity as it is reflected from the surface that you are examining. Record this reading also. Obtain these two readings from as many different surfaces as possible.

Digging Deeper

What method did you use to best display the information that you collected?

In this experiment what was the "control" situation?

In this activity you measured the amount of light reflected from different surfaces. How could you discover the amount of the sunlight that was absorbed by a surface?

What surface reflected the most light? the least?

Did all parts of a lawn reflect the same amount of sunlight?

What colours seemed to reflect most light? Did you take enough readings to make a reasonable assumption?

Do you think that there is any connection between the reflection of sunlight from a surface and its temperature? How can you find out?

The length of time that the sun shines on a mini-climate is also very important

What difference in reflected light did you find when the bristol board was removed?

to the living things that live there. No doubt you already know that we receive sunshine for different lengths of time during the year. During the summer when you wake, the sun is shining brightly, but during the winter it is dark when you wake even though you rose at the same time. You may not fully appreciate just how much change occurs in the daylight period during the year.

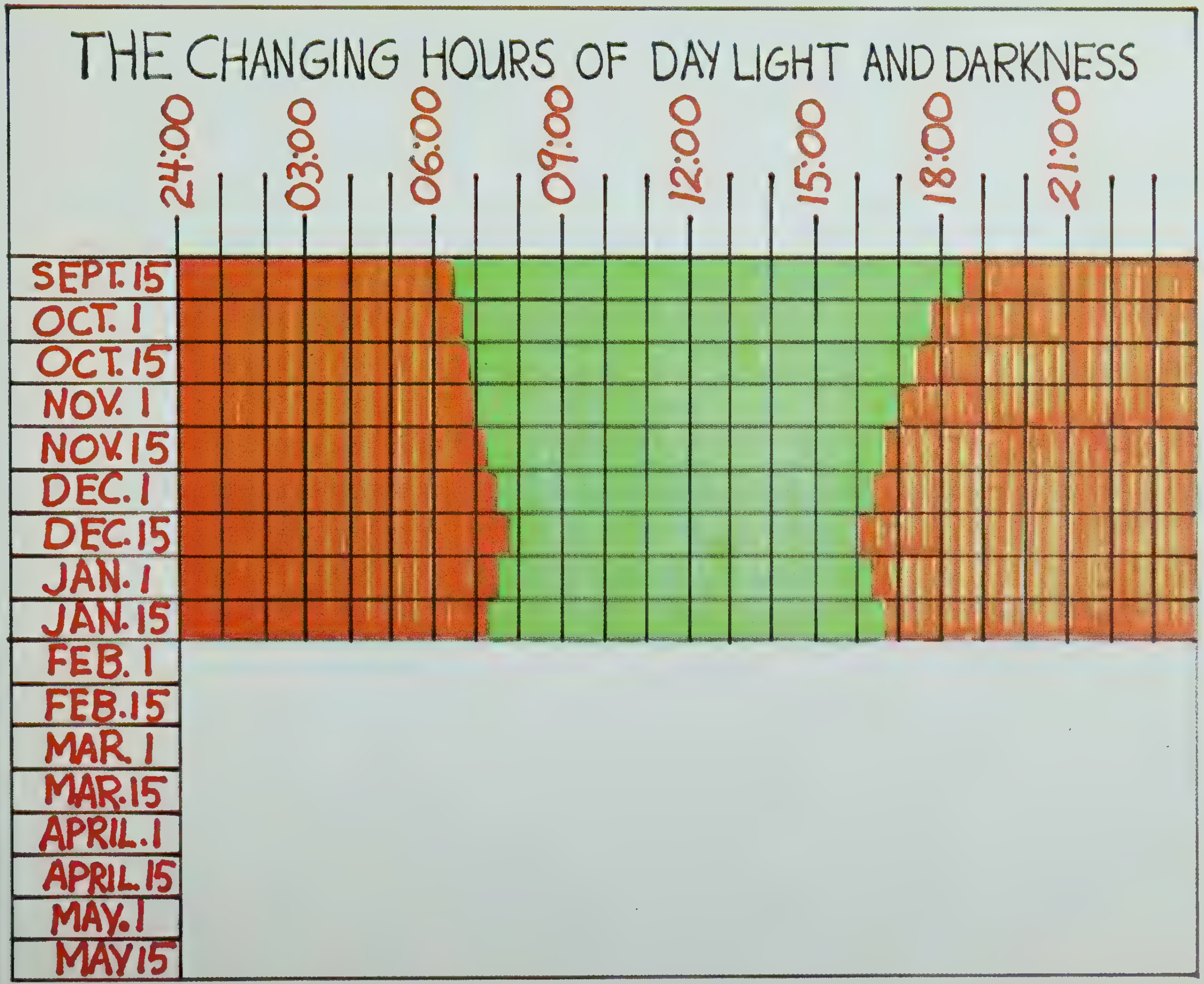
Activity 3:

How does the length of daylight vary throughout the year?

Keep a record of the sunrise and sunset times as recorded in your local newspaper for one week.

Examine old newspapers or almanacs or consult with your local weatherman to obtain the time of sunrise and sunset for each Monday during the past year. Record this information on a graph like the one shown below.

Obtain the high and low temperature for each day shown on the graph and record this information also.



Digging Deeper

About how much did the length of daylight change each day?

How long was the longest period of daylight? the shortest?

At what time of year was the period of daylight longest? shortest?

At what time of year was the period of daylight and darkness approximately the same?

At what time of year was the temperature the lowest?

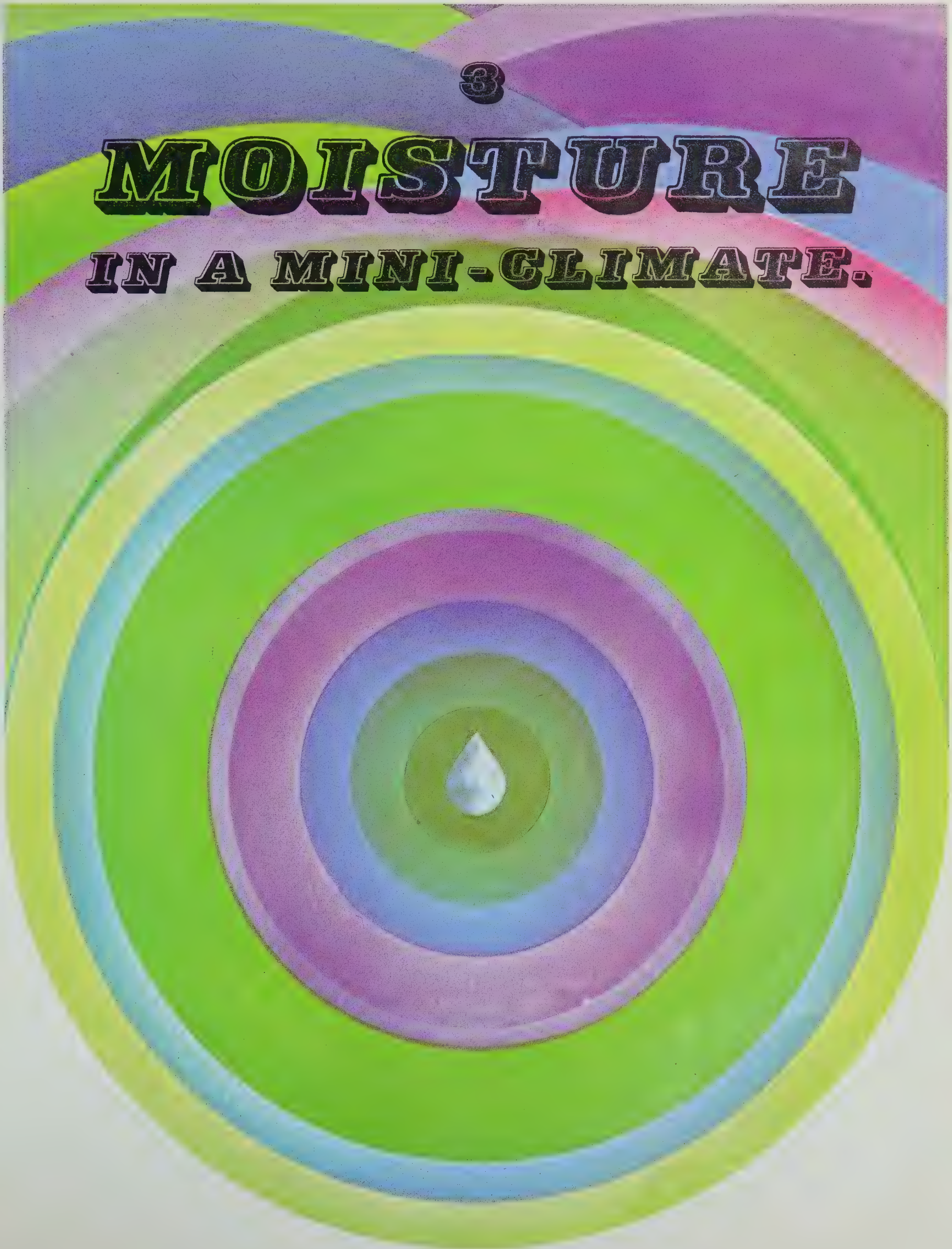
What might account for low temperatures at that time of year? Can you suggest any other reasons?

HIGH AND LOW TEMPERATURES

DATE	HIGH TEMP.	LOW TEMP.
SEPT. 15	23°C	11°C
OCT. 1		

3

MOISTURE IN A MINI-CLIMATE.



All plants and animals live in one mini-climate or another. In each mini-climate there are different amounts and kinds of moisture. Suppose you are standing on your front lawn or on a sidewalk, how many different types of moisture can you discover? Do you see dew on the plants, puddles on the ground or rain? The humidity in areas where there is an abundance of vegetation, such as a jungle, is always very high. People often talk about the "steaming jungle," where it is hot, sticky and oppressive. On the other hand, the Sahara Desert, "bone dry," with its lack of vegetation and animal life, has a much lower humidity. The same extremes in moisture that are found in these two areas can also be found only centimetres apart near the surface of the ground in such places as a grassy jungle (lawn) and little deserts (sand pit or shoulder of the road). Each tiny area can become a research station for the study of many types of moisture, temperature and life.

There is moisture in the ground, plants, animals and the air surrounding them. Plants take in moisture and give off moisture. A very large number of invertebrates (in·VER·ti·braytz), or animals without a backbone, live in damp, moist places. Man also is to be found located beside bodies of water of all types. Moisture, in all of its forms, is a key factor in determining and controlling temperatures in a mini-climate. It is of great importance to all living things, and to know something about the kinds of moisture and how each can be measured and related to a total mini-climate can be an interesting study. In this chapter we will concern ourselves with the following types of moisture—rainfall and humidity.

What Happens to Rainfall in a Mini-climate?

Normally, rainfall "runs off" over the surface of the ground, evaporates back into the atmosphere, is taken into plants and soaks down through the soil to the water table. Many factors influence this usual pattern of rainfall in a mini-climate. Buildings, trees, bushes, fences, and other objects can cause extremely heavy rainfall on one side and very little on the other. In other areas tiny ponds and lakes may develop. These conditions will cause different little climates, different little habitats and a difference in the types of organisms (OR·ga·nizmz) found. Rainfall is of great importance in determining the type of mini-climate that will be found, as well as the organisms in it.

To measure the effect of rainfall on a mini-climate, it will be necessary to construct some equipment and learn to use it effectively. Care should be taken when doing an activity to choose the most suitable device with which to examine the rainfall. In each activity the measurements should be taken many times in order to reduce the possibility of error. Some activities will require that measurements be taken over longer periods of time.

Where should Cindy place a second rain gauge?

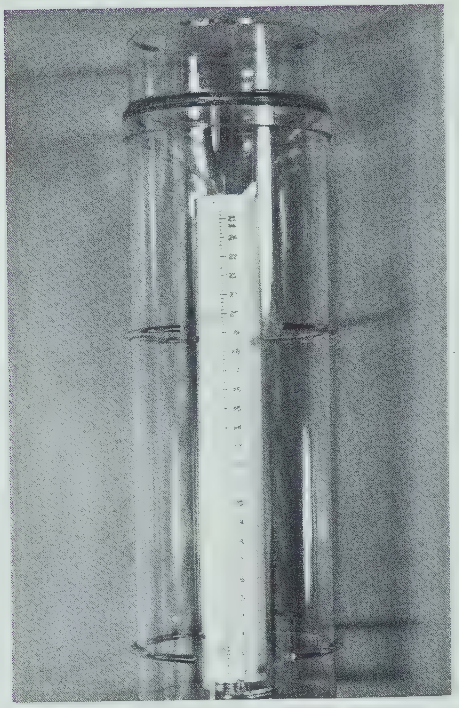
Activity 1:

How to make and use rain gauges

How to make and use a tobacco can Alka-Seltzer bottle rain gauge.

Obtain a large Alka-Seltzer bottle, a tobacco can, masking tape and a popsicle stick. The tobacco can will be used to collect the rain and the Alka-Seltzer bottle will be used as a gauge.

To put measurements on your rain gauge, pour exactly 5 mm of water into the tobacco can. Use the popsicle stick that has been carefully marked 5 mm from the end to test the accuracy of the level of water in the bottle.



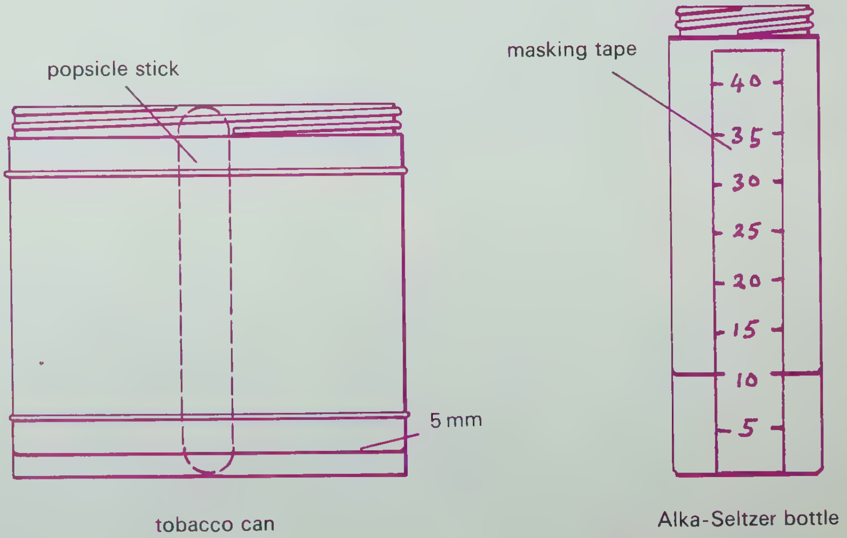
Carefully pour all of the water in the can into the Alka-Seltzer bottle.

Place a piece of masking tape along the side of the bottle.

Mark the level of the water in the bottle on the masking tape. Label the mark—5 mm. Place a mark on the masking tape double the distance from the inside bottom of the bottle to the 5 mm mark.

This would be the 10 mm level. How could you find the 20 mm level? The 2.5 mm level? Complete the scale on the Alka-Seltzer bottle.

In order to find out how much rain has fallen, pour the water that has been collected in the tobacco can into the Alka-Seltzer bottle, your home-made graduated cylinder.



Place the tobacco can on the lawn and record the amount of rainfall for two or three weeks.

What is the average rainfall for that period in your area? How can you find out?

Activity 2:

What effect has a bush on the amount of rainfall reaching the ground under it?

Obtain several rain gauges of the same type.

Place one rain gauge under a small bush or evergreen and the other in a nearby open area.

After each rainfall, record the amount of rainfall collected in the locations selected. Your records should indicate the area, date and time.

After several such readings have been taken, organize and display your facts in a meaningful manner.

Digging Deeper

How did the amount of rainfall collected from the two areas compare?

Feel the soil in the two areas to compare dryness.

What is the reason for the difference in rainfall?

Use your rain gauge to determine the amount of water falling from a garden sprinkler.

Branching Out

Place your rain gauges under different types of bushes and trees and compare the rainfall collected.

Place rain gauges near the centre and at the edges of a bush.

How do the amounts of rainfall collected compare?

After a rainfall, measure the depth to which the moisture has soaked into the ground under a bush and in the open area surrounding it.

Make some cobalt chloride (KOH·bolt KLOHR·eyd) paper and test the dryness of the soil in different semi-sheltered areas after a rainfall. To make cobalt chloride paper, purchase 30 g of cobalt chloride from a drugstore. Prepare a solution of 10 ml of cobalt chloride and 5 ml of common table salt dissolved in a cup of water. Immerse white blotting paper in the solution and let it soak. To dry the blotting paper, preheat an oven to 150°C, turn off the heat and then place the cobalt chloride paper in the oven on aluminum foil. Keep turning the paper until it is a deep blue colour. Be careful not to scorch it. Once you have it completely dry, store the cobalt chloride paper in an air-tight jar or container for protection against moisture.

When cobalt chloride paper is perfectly dry it is a deep blue colour. When it is wet it is pink. Cobalt chloride paper can be used to measure the approximate amount of moisture present in the soil or air by noting the shades of blue or pink. Compare the amount of moisture in the soil under a bush, stone and log before and after a rainstorm. Perhaps you can think of other uses for the cobalt chloride paper.

Activity 3:

How does the force of raindrops affect the following: a grassy area, sandy area, garden area, shoulder of a road?

Construct several splash pillars.

(a) Obtain some light coloured construction paper, three or four milk cartons, stones, elastic bands and a magnetic compass.

(b) Fold the construction paper around the milk carton so that all four sides are covered and use the elastic bands to hold it in place.

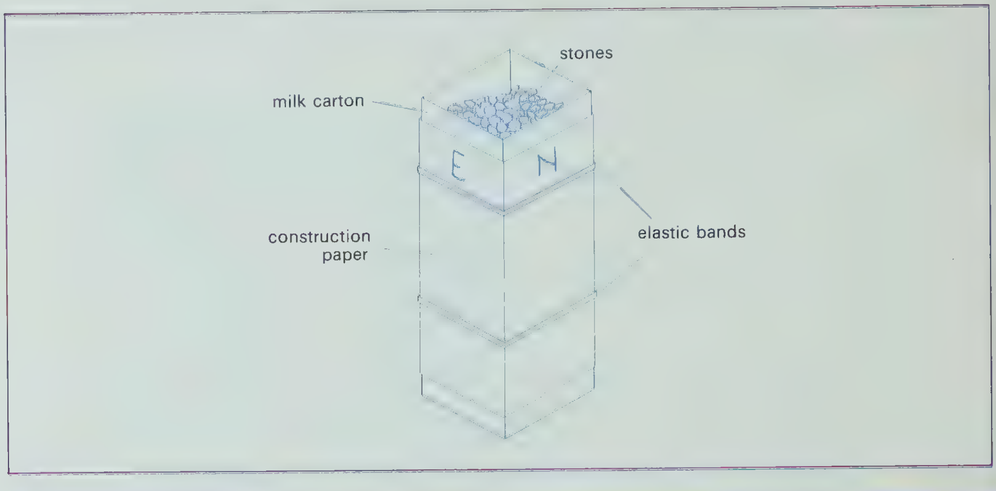
(c) Place some stones in the bottom of each carton to hold it in place.

(d) Mark N, S, E, and W on the top of each side.

Place the splash pillars outdoors in the areas suggested in the problem. If possible, they should be put out at the beginning, middle and end of a rainstorm. New construction paper would have to be put on the splash pillar each time. Position the splash pillars in a N, S, E, and W direction by using the compass.

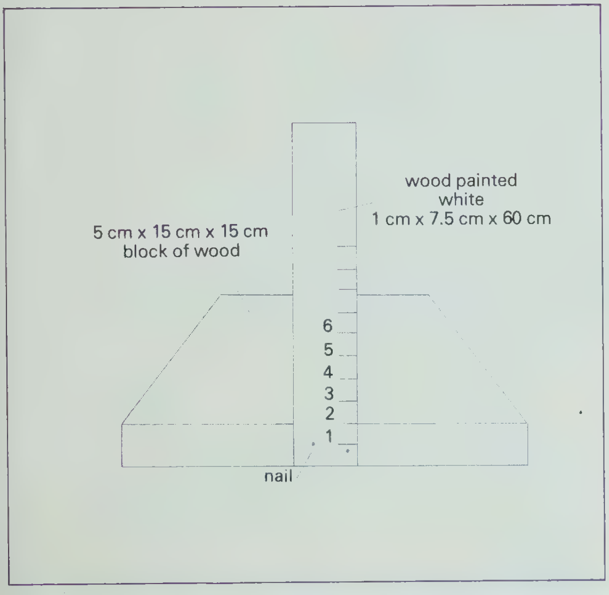
The splash pillars shouldn't remain outdoors during the entire storm, only long enough to obtain some splash records. If left out too long, the rain could wet all the paper erasing the splash marks.

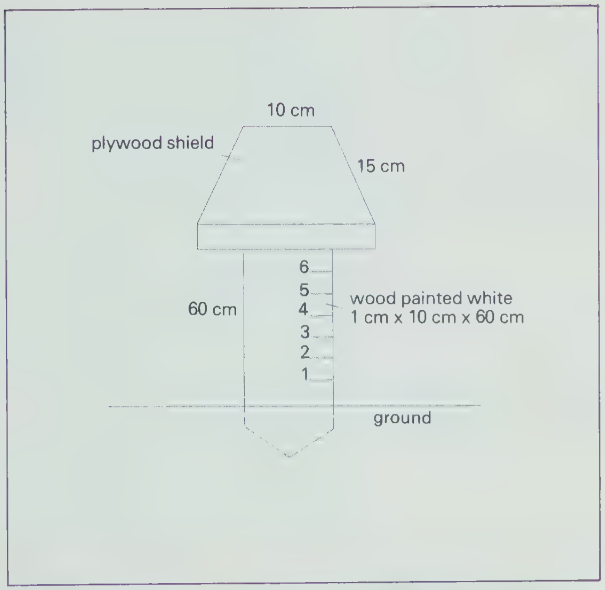
Mount the actual construction paper used on larger sheets of paper and make comparisons.



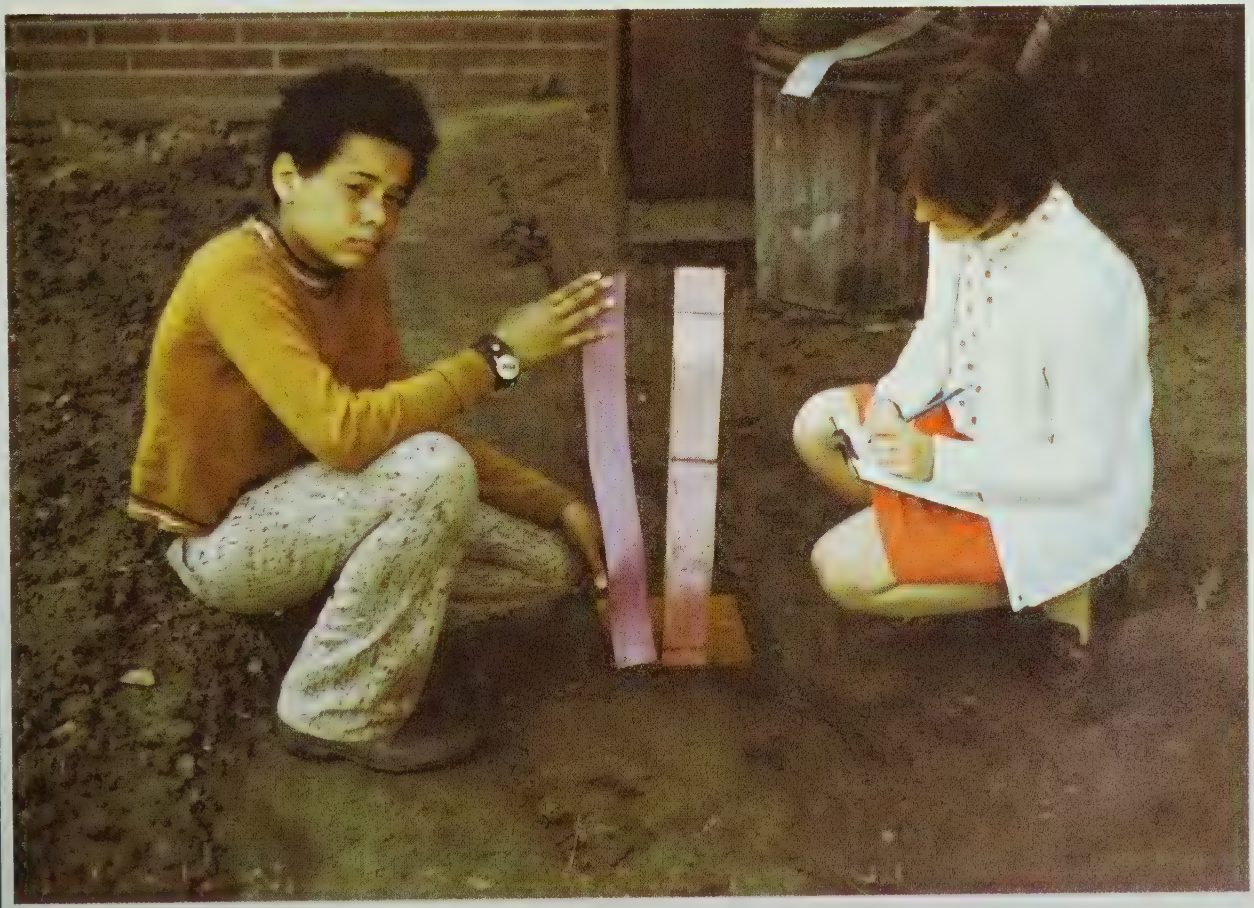
Digging Deeper

On which splash pillar was there the





Here are diagrams of two other splash devices. Perhaps you would like to construct and use one or both of these and compare it to your splash pillar.



These children are comparing splash records from two different areas. Can you suggest what the areas were?

least amount of mud?

In which area were the mud splashes the highest?

On which side of the splash pillar were the greatest number of marks or splashes?

What factors influence the amount and height of the splashes?

Of what value would this type of information be to soil scientists?

Is the same effect produced in the same locations by very heavy rainstorms?

Branching Out

Place splash pillars under trees, bushes and next to fences and buildings. Compare these findings with the ones you have already recorded.

Compare splash records taken over paved areas and bare soil.

Activity 4:

How to construct a device for measuring the size of raindrops.

Make several raindrop collectors.

(a) Obtain the following materials: a flour sifter, lid of a shoe box or pie plates, a ruler, one kilogram of finely sifted flour and some newspaper.

(b) Fill the lid of the shoe box with the flour until it is level with the top edge of the lid.

(c) Use the ruler to smooth the surface of the flour until it is flat and level.

(d) Place a piece of newspaper over the flour for protection against rain while carrying the device to and from the desired area.

On a rainy day or during a rainstorm, take your covered raindrop collector outside. Remove the newspaper cover for about five seconds and let the rain hit the flour, then cover it and return indoors.

Allow the raindrops in the flour to dry out and become hard.

Once the pellets have dried, use the flour sifter to sift out the pellets. How do your raindrop pellets compare with each other?

Activity 5:

How does the size of the raindrops vary in each of the following areas: an open area such as the lawn, under a tree, near the wall of a building, under a bush?

During a rainstorm take raindrop collectors to the areas suggested in the problem.

Expose the collectors to the rain for the same length of time—5 s.

Allow the pellets to dry and then sift them out.

Glue the raindrop pellets, in order of size, onto a strip of black construction paper.

Digging Deeper

In which box did the greatest number of small drops occur?

Which box had the least number of pellets in it?

Which box had the greatest number of pellets in it?

Can you discover any order or pattern in the size of your raindrops?

Compare all of the areas to determine the range in size of the diameters.

Branching Out

If you wish to explore this area of study further, you might attempt some of the following activities in various locations in any mini-climate that interests you.

During a rainstorm, when do the largest raindrops occur: at the beginning, middle, or end?

At any given time during a rainstorm are the raindrops all the same size?

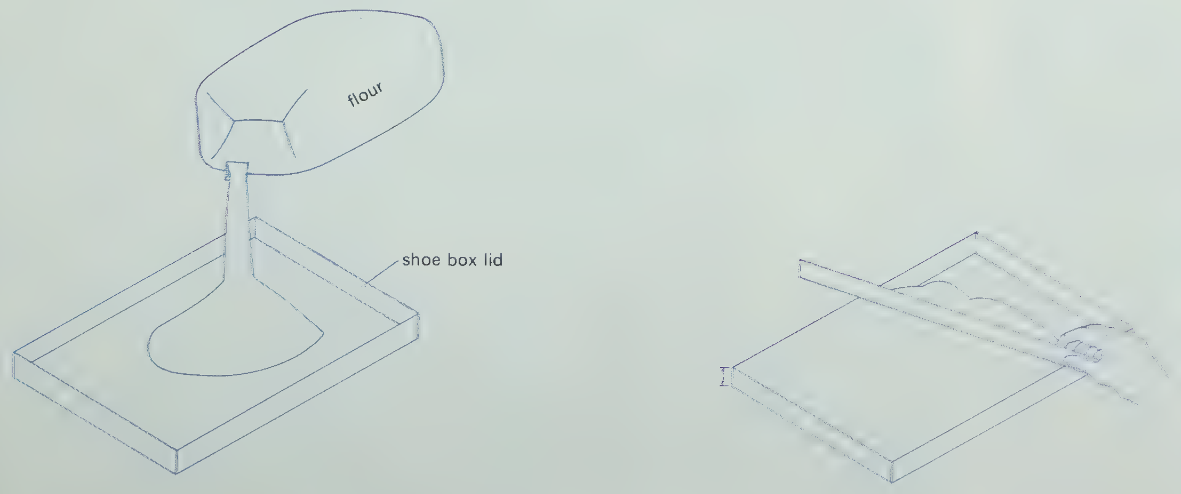
Is there an average size of raindrop?

How can you discover if raindrop pellets are really the same size as raindrops?

After a rainfall, where are the dry areas in your mini-climate? Sketch a map of your mini-climate and indicate the areas on it.

Set up 4 plots. Water one for 15 min, one for 30 min, one for 60 min, and one for 4 h. After you have finished watering in each plot, dig several holes in different places in the plot and measure how far the water penetrated. How does this relate to rainfall?

How good are you at estimating? How many raindrops are in 30 cm^3 of air in a light rainstorm? Heavy rainstorm? How many snowflakes are in 30 cm^3 of air? A cubic metre? What equipment might you use to help you arrive at an answer?



The Raindrop Collector

What is Humidity?

Moisture can fall to the earth as rain, but how does it return to the atmosphere (AHT·moz·feer)? We can discover the answer by examining the water cycle.

Moisture or water vapour (VAY·por) gets back into the atmosphere mostly by evaporation (ee·vap·O·RA·shon). The amount of moisture or water vapour that is in the air at any given time determines the humidity.

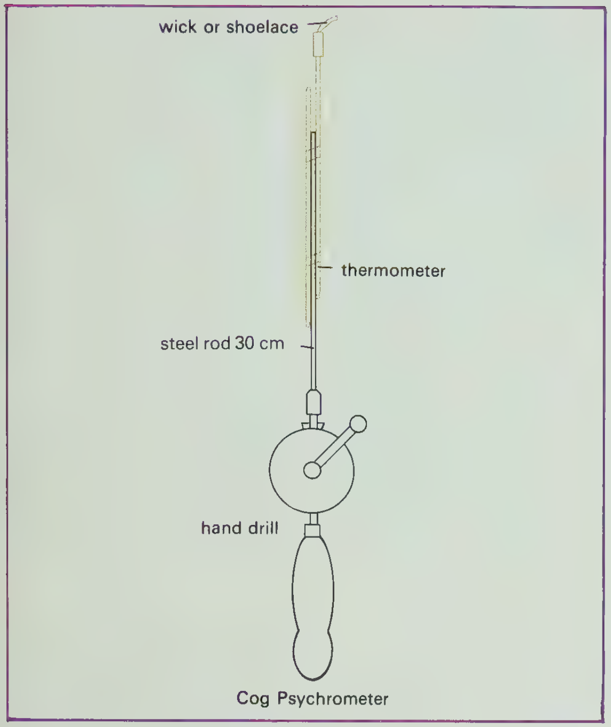
When we measure humidity in a mini-climate, we will refer to "relative humidity." Relative humidity is the amount of water vapour in the air compared to the total amount that the air could hold at that temperature. It is expressed as a percentage.

The relative humidity above different surfaces such as soil, tops of plants, a road, a roof or a puddle of water varies greatly, as does temperature. The table shows the differences in humidity found in areas which are within a few centimetres of each other.

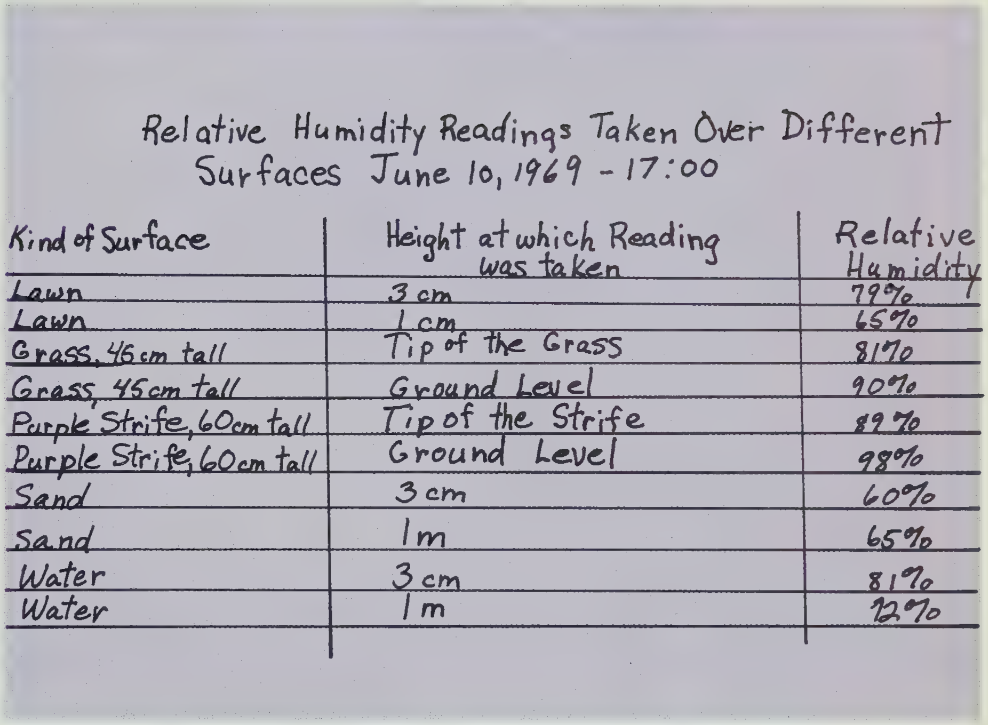
Why is the relative humidity so high around plants? Wide differences in relative humidity determine whether or not plants and invertebrate animals can live in a given mini-climate. These wide differences also affect and in some cases control the formation of dew and frost.

Relative humidity can be measured in many ways. Simple instruments, constructed like those illustrated in the photograph, can be used. Relative humidity can be measured in all types of weather.

Simple instruments for measuring relative humidity can be used to determine the moisture content of the air under bushes or over lawns.



Cog Psychrometer



Relative Humidity Readings Taken Over Different Surfaces June 10, 1969 - 17:00

Kind of Surface	Height at which Reading was taken	Relative Humidity
Lawn	3 cm	79%
Lawn	1 cm	65%
Grass, 46cm tall	Tip of the Grass	81%
Grass, 45cm tall	Ground Level	90%
Purple Strife, 60cm tall	Tip of the Strife	89%
Purple Strife, 60cm tall	Ground Level	98%
Sand	3 cm	60%
Sand	1m	65%
Water	3 cm	81%
Water	1 m	72%

Activity 6:

How does a cog psychrometer (sy·KROM·i·ter) *work?*

Make a cog psychrometer.

Observe and record the temperature on both thermometers.

Moisten the bulb which has the wick on it with distilled water or tap water.

Twirl the thermometers for 30 s and then look at the temperatures again. Record the temperatures.

In order to calculate relative humidity, it is necessary to use a table such as the one shown on page 81. Locate the dry bulb reading on the side scale and the difference between the wet bulb reading and the dry bulb reading on the top scale. Run your fingers along each column until they meet. The number at the point at which they meet is the relative humidity.

Digging Deeper

What was the difference in temperature on each thermometer before the one bulb was moistened and fanned?

Why should distilled water rather than tap water be used to moisten the wick?

What did fanning or twirling the wet bulb thermometer do to the moisture on the wick? What is this process called?

How does this device allow you to measure the amount of humidity in the air? Does the picture of the water cycle provide a hint?

How would you measure relative humidity when the temperature is below the freezing point? Here is what the scientists do. See if it will work for you. If the temperature is at or below the freezing point, remove the wick from the thermometer and apply a small amount of water directly to the bare bulb. A thin coat of ice will form on the bulb and evaporation from the frozen surface will go on as before.

It is very important that careful observations be made when reading the wet and dry bulb thermometers. There should be as little time as possible wasted between the time the twirling is stopped and the time the readings are taken.

Activity 7:

What is the relative humidity at about one inch above the following surfaces: sand pit, asphalt, cement, soil in flower beds, lawn in the open, lawn under a tree, gravel at the edge of the road, a large leaf.

Use the cog psychrometer to measure the relative humidity over the areas suggested in Activity 7.

Display your information in a table or a graph.

Digging Deeper

Over what surface was the relative humidity the highest? Why?

Over what surface was it the lowest? Why?

In which area would you expect to find the most animal life? Why?

What was the difference in relative humidity between the surfaces with the highest relative humidity and the lowest relative humidity?

Activity 8:

How does relative humidity change with height above the following surfaces: asphalt on a road; grassy field.

Use the cog psychrometer to measure the relative humidity in the places mentioned by taking readings at 15 cm intervals beginning at 2.5 cm and going up to 120 cm above the surface.

Record your facts in a table similar to the one on the following page.

Digging Deeper

At what height above each type of surface was the R.H. greatest? Why?

What was the difference between the 3 cm and 120 cm reading in R.H. in each area?

Compare the range in both areas at the 3 cm level? 60 cm level? 120 cm level?

At what height did the R.H. tend to be the same?

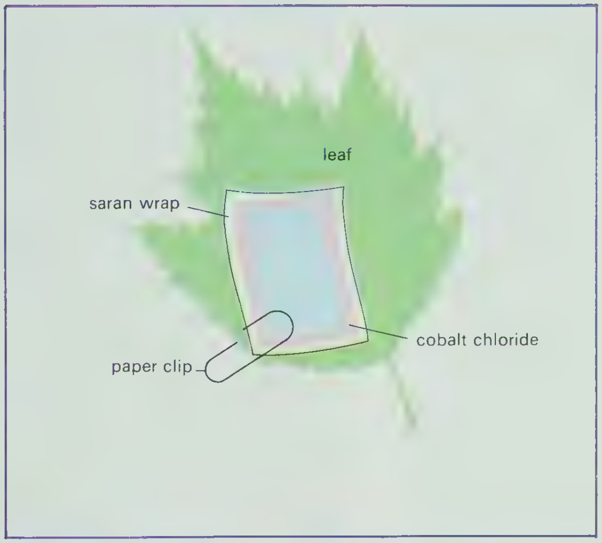
Compare two other areas such as bare ground and the lawn in a similar manner.

Activity 9:

What is the rate of transpiration (TRAN·spi·ray·shon) *from the leaf of a plant?*

How Does Relative Humidity Change With Height Above an Asphalt Road And a Grassy Field?

Height	Relative Humidity	
	Asphalt on a Road	Grassy Field
120 cm		
105 cm		
90 cm		
75 cm		
60 cm		
45 cm		
30 cm		
15 cm		
2.5 cm		

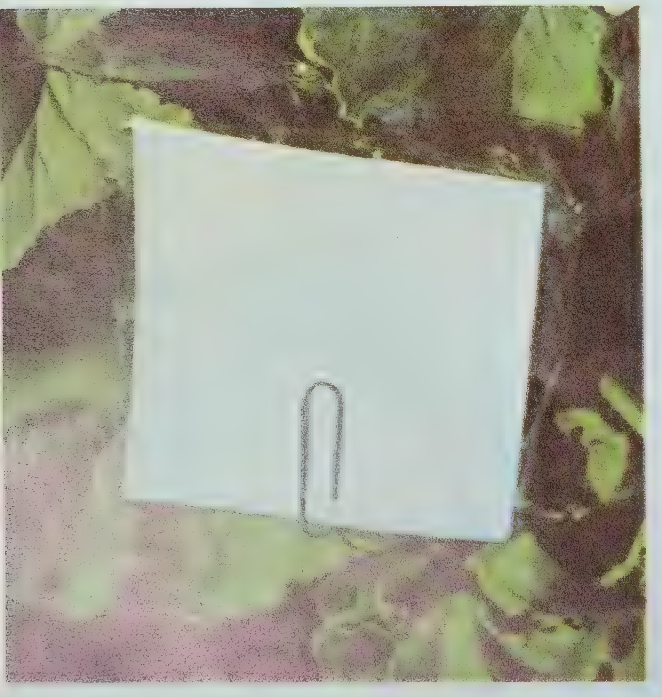


Obtain some saran wrap, a piece of dry cobalt chloride paper, a paper clip and a watch. If saran wrap is not available use two pieces of glass, acetate (AZ·i·tayt) or cellophane paper, or scotch tape.

Select the leaf of a plant and proceed to make a "sandwich" as shown in the sketch. You could try putting cobalt chloride paper on both sides of the leaf or just one side at a time.

Measure the time it takes the cobalt chloride paper to turn from blue to pink. This will give you some idea of the rate of transpiration of the leaf. Observe colour changes over various lengths of time.

Repeat the activity with several other leaves on the same plant considering variables such as shape, size and location. Use the leaves of the other plants such as geranium, spruce tree, maple tree, grass, African violet and water lily.



Digging Deeper

Do the leaves of the same plant transpire at the same rate?

Does the size of the leaf affect how quickly transpiration takes place?

Do leaves transpire on both sides?

Do leaves transpire more at their margins or centres?

Do leaves with a waxy coating transpire more slowly or faster than leaves with less wax on them?

Does transpiration take place at night or in the dark?

Do stems transpire?

Does a cactus plant transpire?

Do such factors as cloudiness, high winds, and relative humidity affect transpiration?

How would different rates of transpiration affect a mini-climate?

Activity 10:

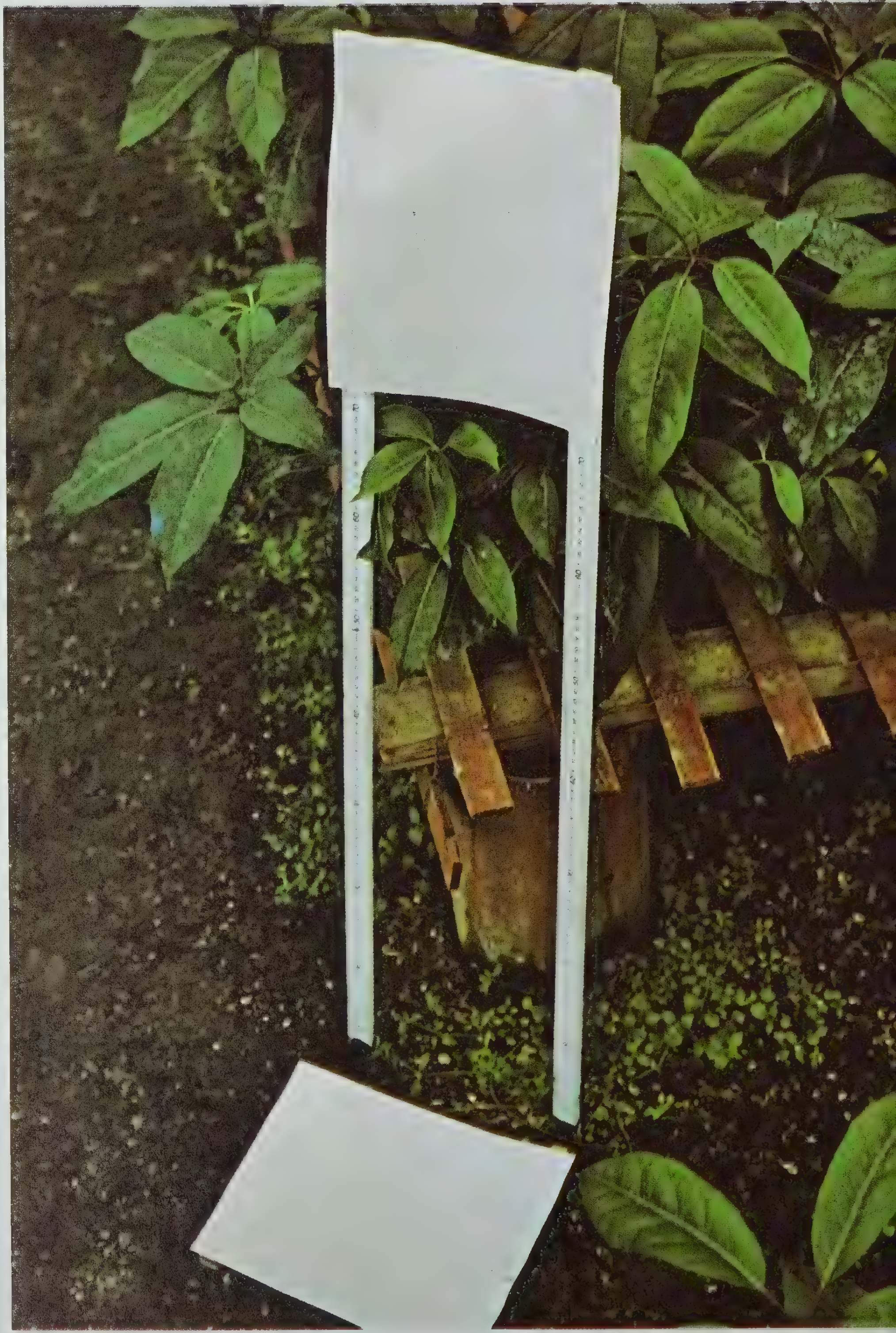
What is the rate of evaporation in various mini-climates?

Moisten two paper towels. Squeeze them so that they are just damp.

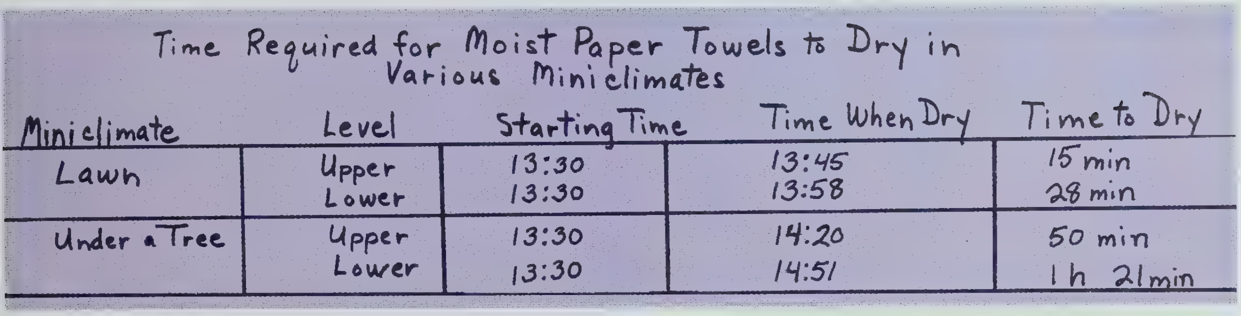
Place one towel on top of a metre stick and the other just above the ground in various mini-climates.

Prepare a chart like the one shown.

Record on it the time that you placed each towel in its place and the time when the towels were completely dry.



These children are using the book as a guide to set up the equipment for measuring evaporation at different levels.



Time Required for Moist Paper Towels to Dry in Various Miniclimates

Miniclimate	Level	Starting Time	Time When Dry	Time to Dry
Lawn	Upper	13:30	13:45	15 min
	Lower	13:30	13:58	28 min
Under a Tree	Upper	13:30	14:20	50 min
	Lower	13:30	14:51	1 h 21min

Digging Deeper

At which level did the paper towel dry faster in each mini-climate?

In which mini-climate did the towels dry most rapidly?

What were the factors affecting the drying time of the towels in the different locations?

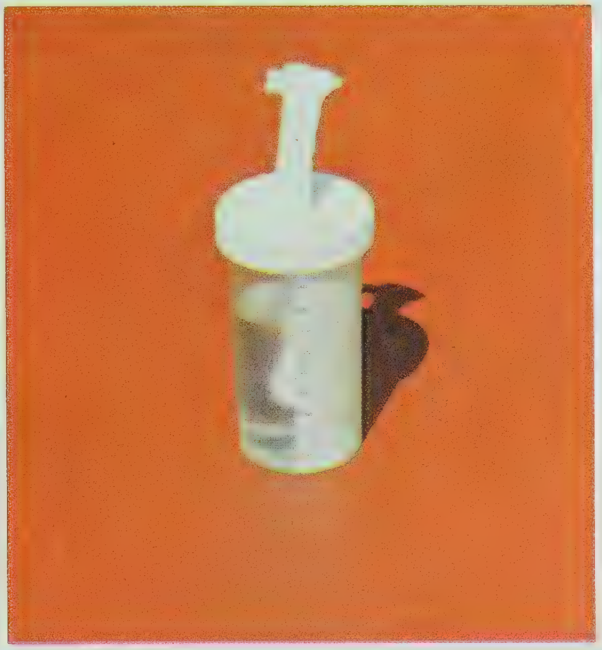
Which of the factors listed above are the most important in determining the rate of evaporation or drying time?

Branching Out

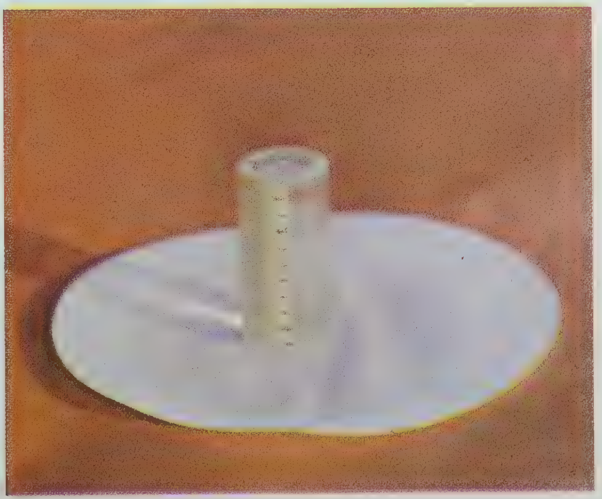
On a calm, sunny day, mark off two plots of ground 2 m x 2 m. Water one of the plots lightly with a hose or watering can. Take temperature readings over the two plots using thermometers on thermometer stands. Compare the readings from each plot. How do you account for the differences in temperature?

Construct several evaporimeters (ee·vap·OR·i·mee·terz) and measure the rates of evaporation in the following areas: the lawn, in tall grass, under a bush, under a tree, on a roof.

Wrap saran wrap completely around a leaf. Observe what happens.



Shoelace Evaporimeter



Filter Paper Evaporimeter.

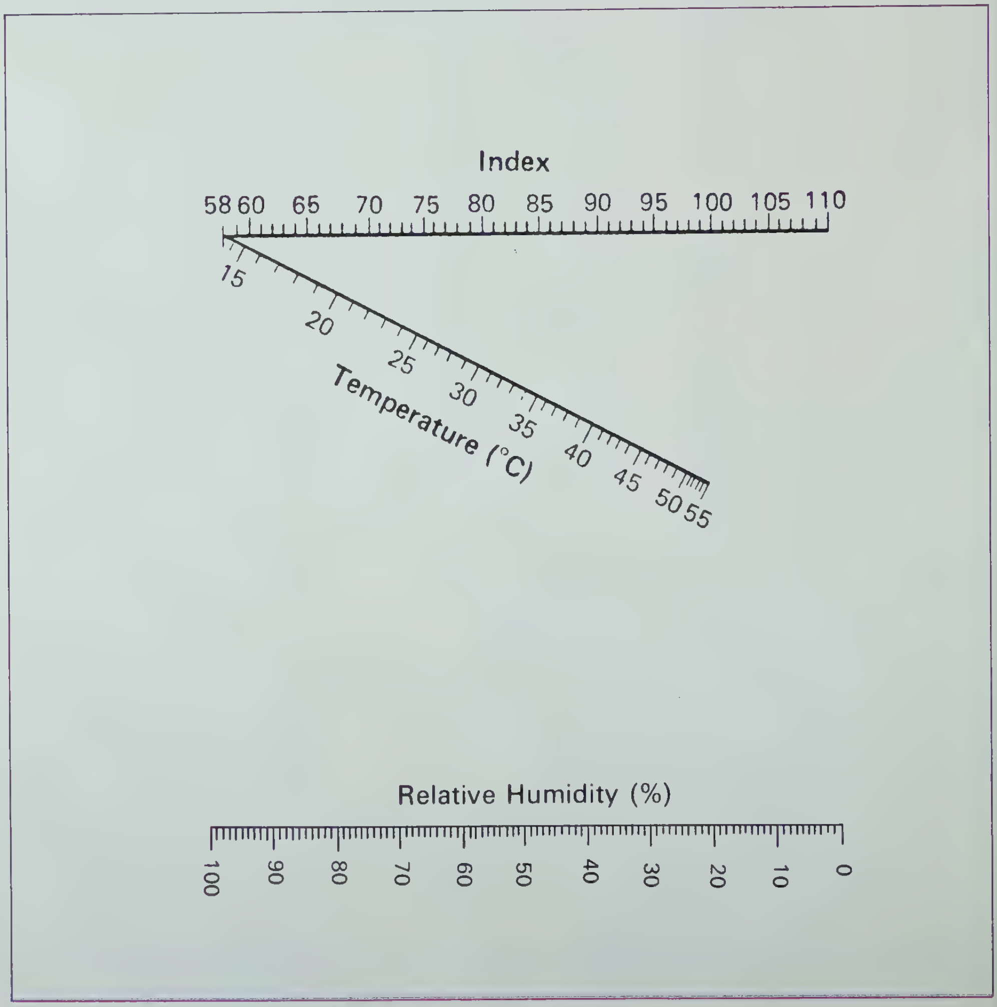
While a leaf is still attached to a plant, paint it liberally on both surfaces with clear nail polish. Let it dry thoroughly and then pick the leaf.

Tear the leaf diagonally, twisting as you do it, so that a fairly large piece of the dried nail polish comes off. Place the piece of nail polish on a glass slide and examine it under a microscope. Count the number of stomata (openings in the surface of the leaf) impressions. Select other pieces of nail polish from at least ten other parts of the leaf in a similar manner. Are the stomata evenly or unevenly distributed? Are they found on both sides of the leaf? Do all leaves have the same distribution of stomata?

Spread petroleum jelly or vaseline thinly over the underside of one leaf, the upper surface of a second leaf, and both surfaces of a third leaf. Observe what happens to the leaf surfaces over a one-hour period. Does this give you a clue as to what happens when a leaf transpires or gives off moisture?

Measuring the Amount of "Discomfort" on a Summer Day

The amount of discomfort that you feel on a muggy summer day depends on the temperature and the amount of moisture in the air (relative humidity). You can measure how uncomfortable it is on a summer day by using this chart. Place a ruler so that it connects the relative humidity and temperature and cuts the line that is labelled "index." (You can find the relative humidity reading by using your psychrometer and the temperature by reading your thermometer.) Where your ruler cuts the "index line" you can read the degree of discomfort. Some people feel uncomfortable when the index reading is 69. Most people are uncomfortable when the reading is 80 or more. At what reading do you find that you are uncomfortable? What are some things that you can do in the summer to reduce the discomfort?



4

WIND

IN A MINI-CLIMATE.

This chapter does not deal with hurricanes or other violent winds. It is concerned with the investigation of the tiny air movements found near the ground.

What Causes Wind?

Wind can be defined as air that is moving. Air may be set in motion in many ways. Usually winds originate when a difference in temperature is created. Differences in the colour, slope, texture, and the material of a surface all help to produce temperature differences which, in turn, start air moving.

Why is Wind Important in a Mini-climate?

When the air is not moving and there is no wind, some weather conditions, such as temperature, are often intensified. Extremes occur because there is no mixing of air of different temperatures.

When a wind is blowing, the rate of evaporation of water is increased. This increase will in turn speed up the rate at which moisture is removed from soil, vegetation and small animals.

As air cools, it becomes heavier and will flow downhill. This type of movement is called air drainage. Air drainage may cause puddles of cold air to gather in low-lying places. These puddles affect the formation of dew and frost.

The speed at which the air is moving over an area often affects the type of life which can exist there. Near the ground in a grassy field there is usually no wind. Above bare ground nearby, the air may be travelling at several kilometres an hour. Many forms of small animal life cannot live in a habitat where there is strong wind.

What is Wind Velocity?

Wind velocity refers to the speed at which the wind is travelling past a certain point. When the speed of a moving object is being measured, two factors are usually taken into consideration: distance and time. For wind speed, distance is measured in kilometres and time in hours. Therefore, the unit used to measure wind speed is kilometres per hour (km/h).

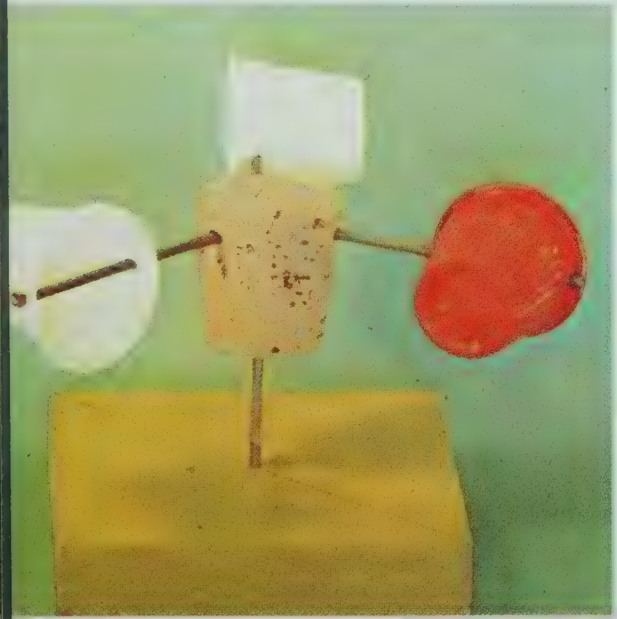
Activity 1:

How can wind velocity be measured?

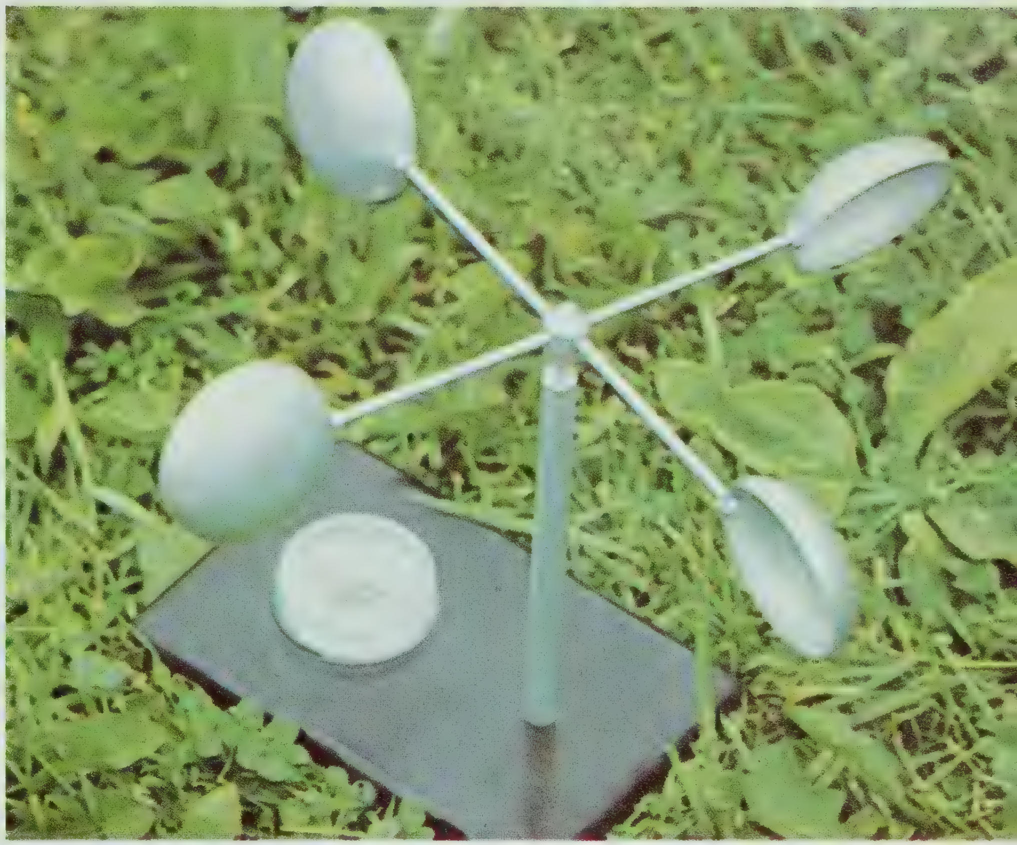
Wind velocity is usually measured by wind speed indicators called anemometers or wind gauges.

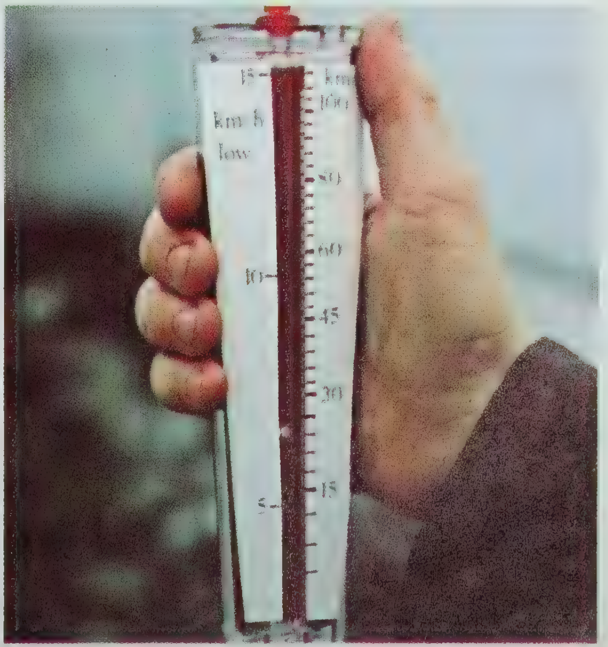
Use the diagrams which follow to help you make several wind speed gauges.

To be useful, the cup anemometer should be made so that it is well balanced and turns freely. A lopsided cup anemometer is not reliable. If your anemometer does not run well you might try making another one in a somewhat different way. Instead of using cork, obtain a one-hole rubber stopper (#8). The anemometer will turn more *hat do these wind devices measure?*

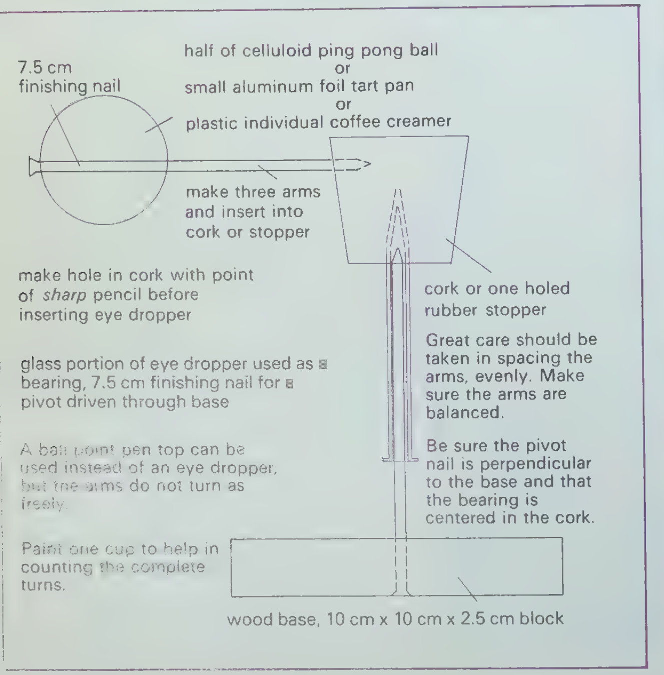


Which part of this device is not required when measuring wind speed?





Some materials from which an anemometer can be constructed.


7.5 cm finishing nail
half of celluloid ping pong ball
or
small aluminum foil tart pan
or
plastic individual coffee creamer
make three arms and insert into cork or stopper
make hole in cork with point of *sharp* pencil before inserting eye dropper
cork or one holed rubber stopper
glass portion of eye dropper used as a bearing, 7.5 cm finishing nail for a pivot driven through base
wood base, 10 cm x 10 cm x 2.5 cm block

Great care should be taken in spacing the arms, evenly. Make sure the arms are balanced.

Be sure the pivot nail is perpendicular to the base and that the bearing is centered in the cork.

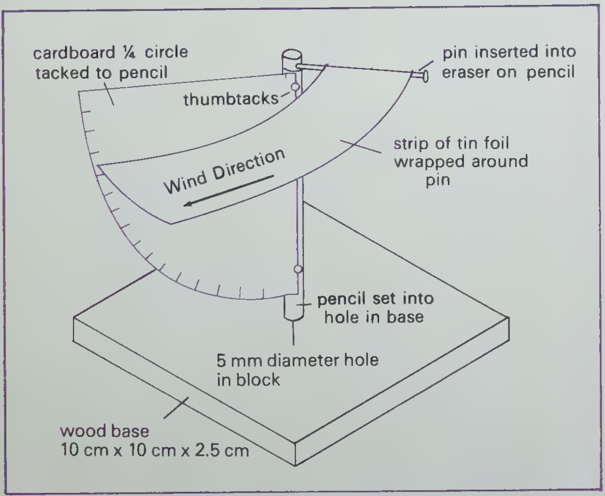
A ball point pen top can be used instead of an eye dropper, but the arms do not turn as freely.

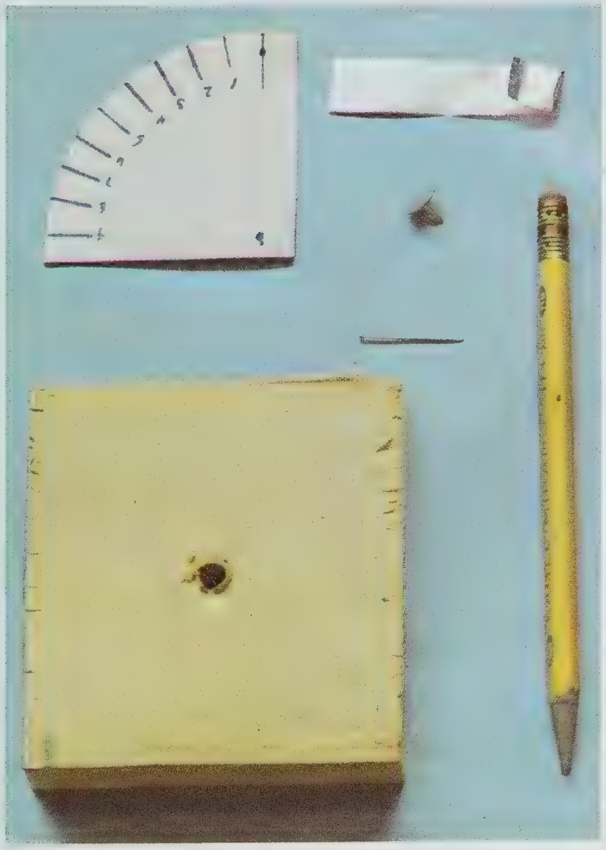
Paint one cup to help in counting the complete turns.

This student is melting and cutting off the end of a glass tube to make a bearing.

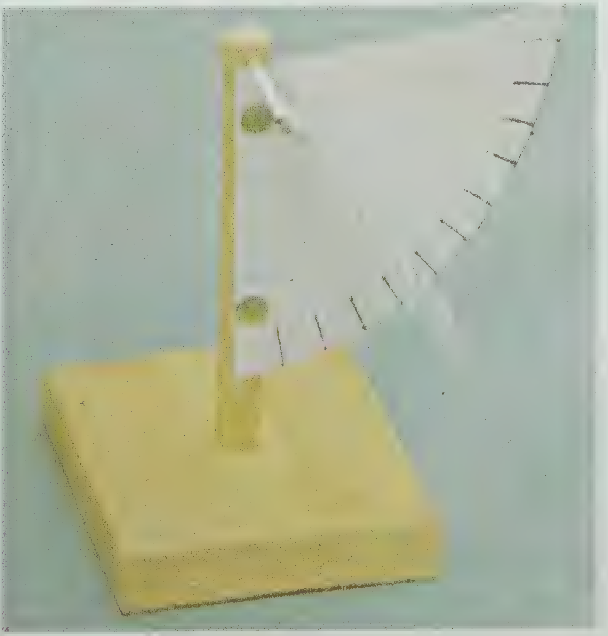
easily if a glass bearing is used in place of the eye dropper. To make a glass bearing obtain a 5 cm length of glass tubing and round off one end by carefully turning it in the flame of a propane torch. (Caution: Have your teacher or a parent help with this step.) Push the glass bearing into the hole of the rubber stopper.

Select a calm day. Calibrate (KAHL·i·brayt) the cup-type anemometers by holding them out of the window of a car which is moving at a steady speed. Start with a speedometer reading of 8 km/h per hour and count the number of complete turns, or revolutions, of the anemometer in 30 s. Increase the car speed by 8 km/h intervals until a speed of 48 km/h is reached. At each interval count the number of revolutions of the anemometer in 30 s. Repeat your trials for each car speed several times and take an average. The information, when recorded on a chart, might look like the chart on page 46.





The materials from which a fan-type anemometer can be constructed.



A completed fan-type anemometer

No. of Revolutions in 30 s	Velocity of Wind in km/h (car's speed)
1. 35	8 km/h
2. 60	16 km/h
3. 77	24 km/h
4. 90	32 km/h

The fan-type anemometers can be calibrated by simply placing equally spaced marks on the scale and numbering the marks in a sequence.

Practise measuring the wind velocity with the cup-type anemometer by counting the number of revolutions made by the painted cup in 30 s. Compare this number with the appropriate column on your calibration graph in order to determine the speed of wind. What wind speed would 100 r in 30 s indicate, if the figures in the chart above were used?

You could use the anemometers without having calibrated them in km/h. To do this select a day when a steady breeze is blowing. Place the anemometers out-of-doors in a place well open to the wind. Count the number of revolutions made by the painted cup in one minute. Repeat this procedure when winds of other velocities are blowing. Instead of recording wind velocity in kilometres per hour, you would now use units called revolutions per minute (r/min).

Digging Deeper

What are some of the advantages of using "revolutions per minute" wind speed.

What are some of the disadvantages of measuring wind speed this way?

What arithmetic could you do to convert revolutions per minute (r/min) into revolutions per second (r/s)?

Consult a dictionary to discover the meaning of the word "arbitrary." How does this word apply to your units?

Note: Another way to calibrate the fan-type anemometer would be to place equally spaced marks along the edge of the cardboard protractor. The marks could be numbered in order from 0 at the bottom to 10 at the top. When using this type of scale you could express the wind's speed as mark one, mark three, etc.

A method of estimating wind velocity is based on the Beaufort Scale. How could you use the Beaufort Scale to help calibrate your wind gauges?

Modified Beaufort Wind Scale

What to Look For	*Wind Speed in Kilometres per hour at 10 m above the ground*
Smoke rises vertically	Less than 1.6
Smoke, but not wind vanes, shows wind direction	1.6 — 5.0
Wind felt on face; leaves rustle; wind vane moves	6.0 — 11.0
Leaves and small twigs moving constantly; small flags extended	12.0 — 19.0
Dust and loose paper raised; small branches moved	20.0 — 29.0
Small leafy trees swayed	30.0 — 38.0
Large branches moving; whistling heard in telephone wires	39.0 — 50.0
Whole trees in motion	51.0 — 61.0

Select a day when a gentle breeze is blowing. Place at random on the lawn or playground all the anemometers which you constructed. Get some friends to help you. Read all the anemometers at the same time and record your observations.

Digging Deeper

Did all the anemometers show the same wind speed? What may be some reasons for this? Which type of anemometer shows small changes most quickly?

Why was it necessary to count the revolutions for a period of at least thirty seconds?

Why might it be necessary to also use a wind vane along with the fan-type anemometer?

How does the wind velocity you measured compare with the wind velocity reported or predicted by the weather bureau?

Under what conditions would it be better to use the fan-type anemometer rather than the cup type?

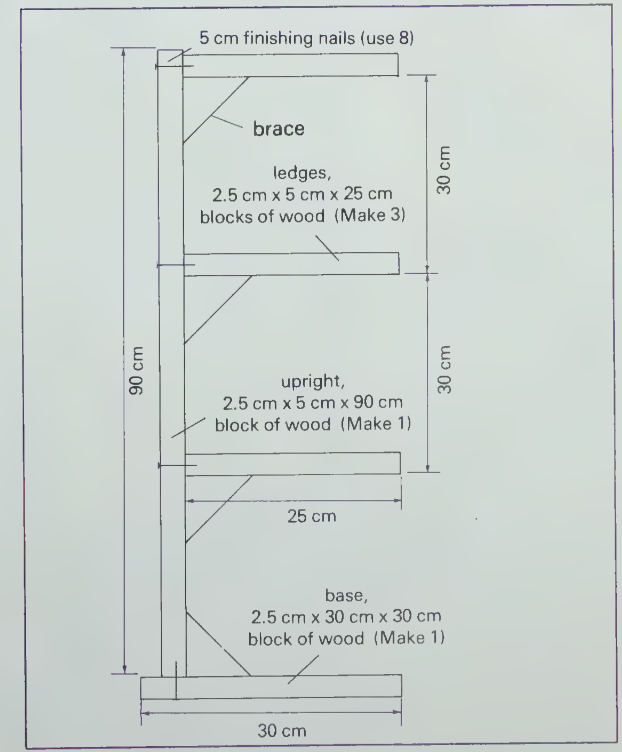
Activity 2:

How does wind velocity change with the height above the ground?

Construct a stand like the one shown in the diagram.

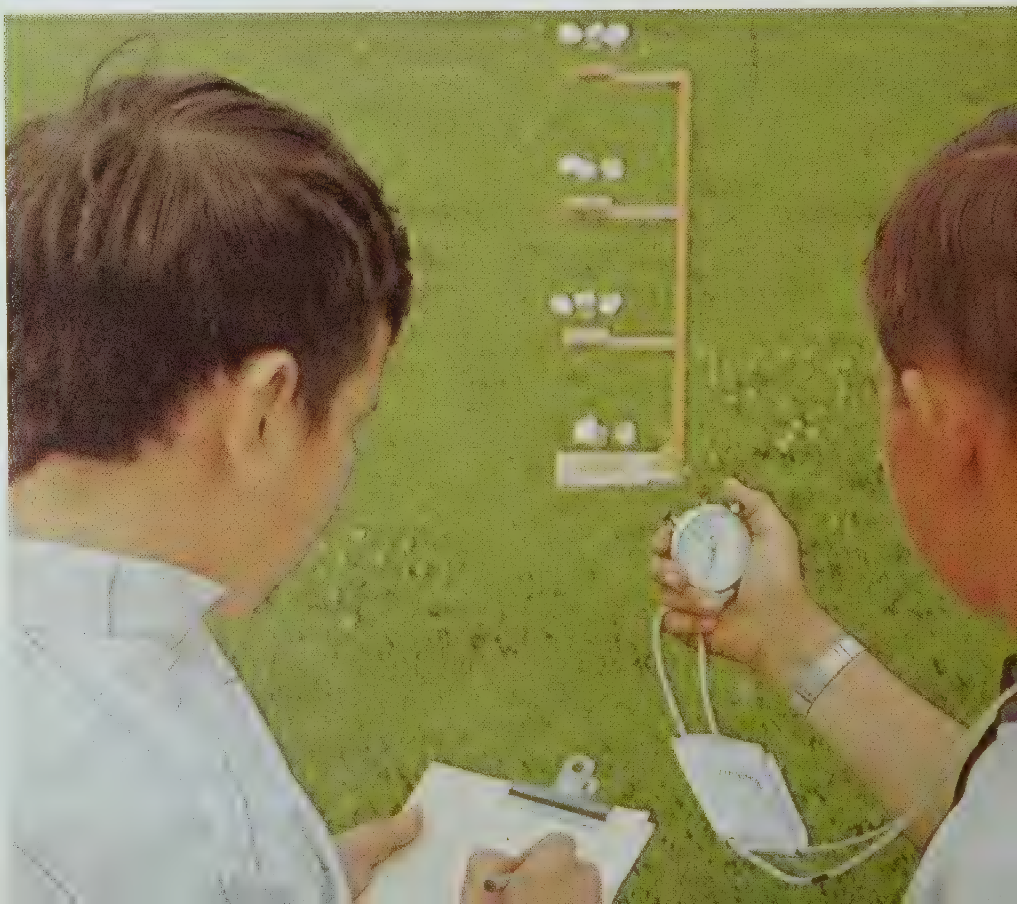
Place the stand in the centre of any open area you wish to select. Use elastic bands to secure your anemometers to the arms of the stand. It may

These are the tools and materials you could use to build an anemometer stand.

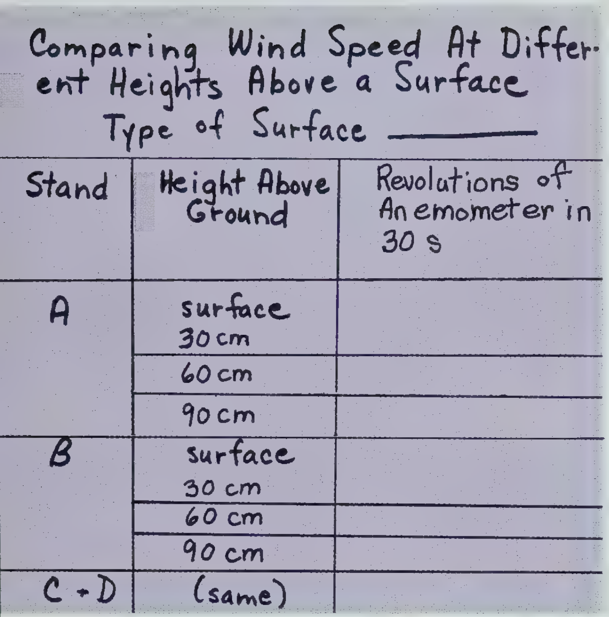


Why would you expect the boys in the bottom photograph to obtain better results?

Why is an elastic band used to attach the anemometer to the stand?



Four anemometers being used at the same time. Do they rotate at the same speed?



Comparing Wind Speed At Different Heights Above a Surface

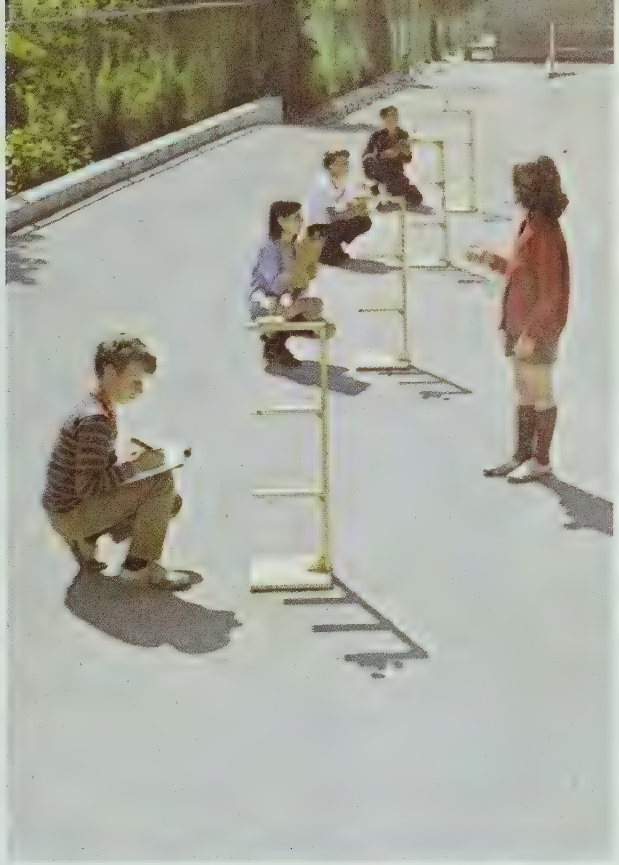
Type of Surface ______

Stand	Height Above Ground	Revolutions of Anemometer in 30 s
A	surface 30 cm	
	60 cm	
	90 cm	
B	surface 30 cm	
	60 cm	
	90 cm	
C + D	(same)	

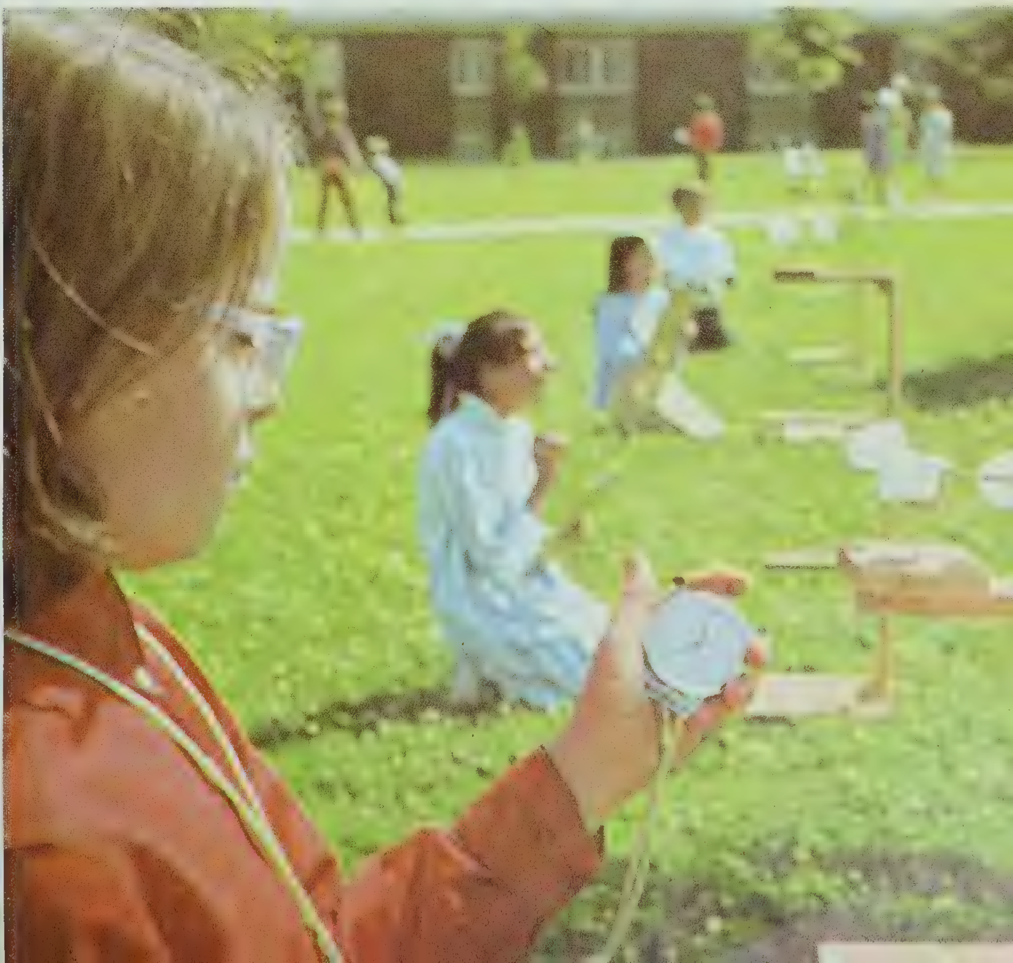
be necessary to dig a shallow pit in order to have the lowest anemometer at ground level. If the wind is strong enough to tip over the stand, pile a few rocks onto the base.

Ask some of your friends to help you in timing and reading the anemometers so that all of the information can be gathered at the same time. If several fan-type anemometers are being used, ask a helper to blow a whistle. Upon hearing this signal, have everyone record the position of the fan on the scale at that instant.

Repeat the activity as soon as possible in such areas as the middle of the lawn, the parking lot, a field of tall grass, under a large tree and any other interesting places you would care to investigate. You and your friends might pool your wind speed indicators so that these areas could be investigated at the same time.



What conditions have these children tried to keep exactly the same as in the top photograph?



Billy is digging a shallow pit in order to find the wind velocity right at ground level.

These friends wanted to help. What should Billy tell them?

Would the wind velocity be the same at grass level as it was at ground level?

Digging Deeper

At what height was the wind speed greatest? At what height was it the least?

Why is it necessary to stay at some distance from the anemometers on the stand?

Why is it necessary to take an average of several anemometer readings?

In which area was the maximum wind velocity recorded? Where was the minimum wind speed found? Where were the velocities the same?

What factors can you observe which might help to explain the differences that you noted?

How could a small step ladder be used in place of the stand?

Why should the anemometers be placed at some distance from all other objects?

How could the wind speed be tested along a ditch, in a tree, through a bush, across a ditch, at other interesting places?

Predict what the wind speed would be in an animal's burrow, under a stone, in or under a rotten log.

Activity 3:

How does wind velocity affect temperature?

Have you ever noticed how much colder you feel on a day when a strong wind is blowing than on a similar type of day when there is no wind? You could use an anemometer and two thermometers to find if the wind of a particular velocity will lower the air temperature.

Choose a day when a steady wind is blowing. Use the anemometer and stand to obtain the velocity of the wind.

Tape one thermometer to the outside of a cardboard box so that it is in the wind. The second thermometer can be taped inside the box so that it is sheltered from the wind. Compare the temperatures shown by the thermometers.

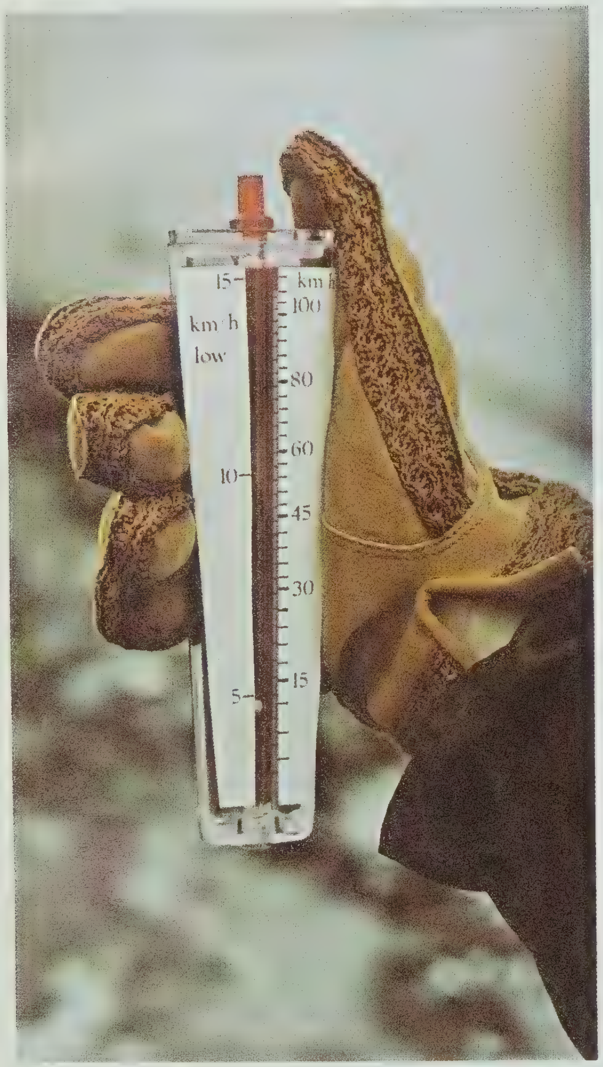
Repeat the experiment when winds of different velocities are blowing.

The degree to which a wind appears to lower the air temperature is referred to as the wind chill factor. The chart shows how cold it can feel when winter winds blow.

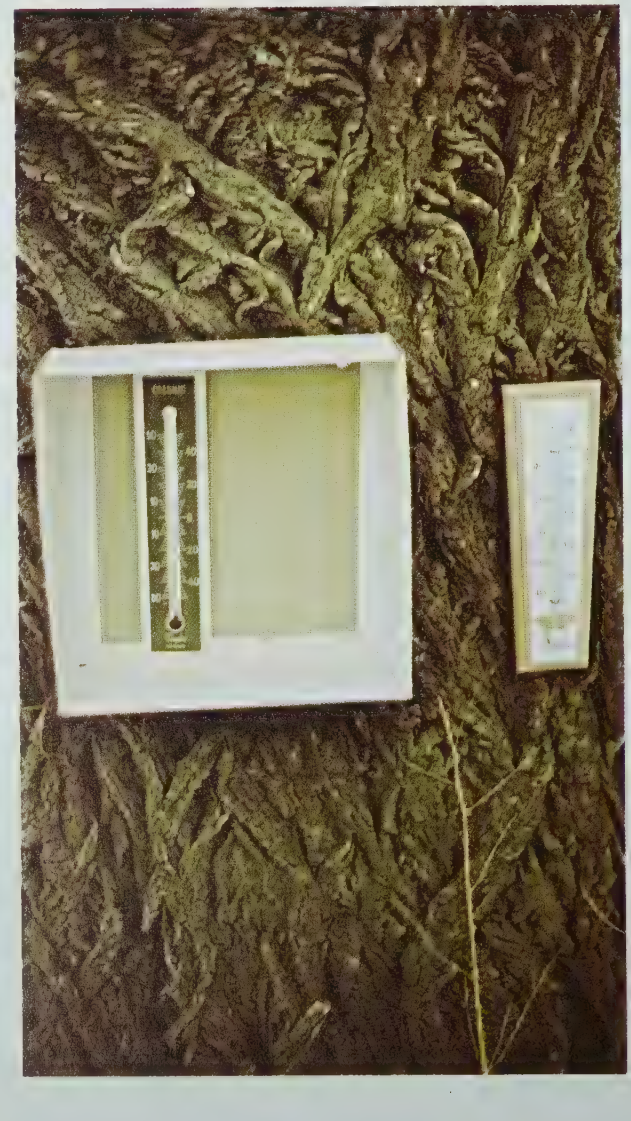
WIND CHILL CHART

Thermometer Readings in Cardboard Box in Degrees Celsius

	°C	0°C	-5°C	-10°C	-15°C	-20°C	-25°C	-30°C	-35°C	-40°C	-45°C	-50°C
Wind speed in Km/n	8	-2	-7	-12	-18	-23	-28	-33	-39	-44	-49	-54
	16	-8	-14	-20	-26	-32	-38	-45	-51	-57	-63	-69
	24	-11	-18	-25	-32	-38	-45	-52	-59	-65	-72	-79
	32	-14	-21	-28	-35	-43	-50	-57	-64	-71	-78	-85
	40	-16	-23	-31	-38	-46	-53	-61	-68	-75	-83	-90
	48	-17	-25	-33	-40	-48	-56	-63	-71	-79	-86	-94
	56	-19	-26	-34	-42	-50	-57	-65	-73	-81	-89	-96
	64	-19	-27	-35	-43	-51	-59	-67	-75	-83	-90	-98
		Gradually increasing danger		Dangerous						Extremely Dangerous		



This type of anemometer gives the wind speed in km/h. This type of information is needed in order to use the wind chill chart.



Which thermometer is sheltered from the wind?

Example: For a thermometer reading of -5° and a wind speed of 16 km/h the chill effect is equal to a temperature of -14°C. What would the wind chill effect be if the air temperature was -15°C and the wind velocity was 24 km/h.

Digging Deeper

Why should the box be placed at the same height above ground as the anemometer?

Compare the two thermometers indoors before using them outside. Why should this be done?

Let a fan blow directly on the bulb of a thermometer for 20 min. Note the temperature before and after. What did you discover?

How long should the thermometers be left out-of-doors before readings are taken with them?

If the temperature readings for both thermometers are the same, what do you think accounts for the reason you feel colder when the wind blows?

How cold would you feel if a 40 km/h wind was blowing and the air temperature was -5°C?

What effect do you think the wind chill would have on plants?

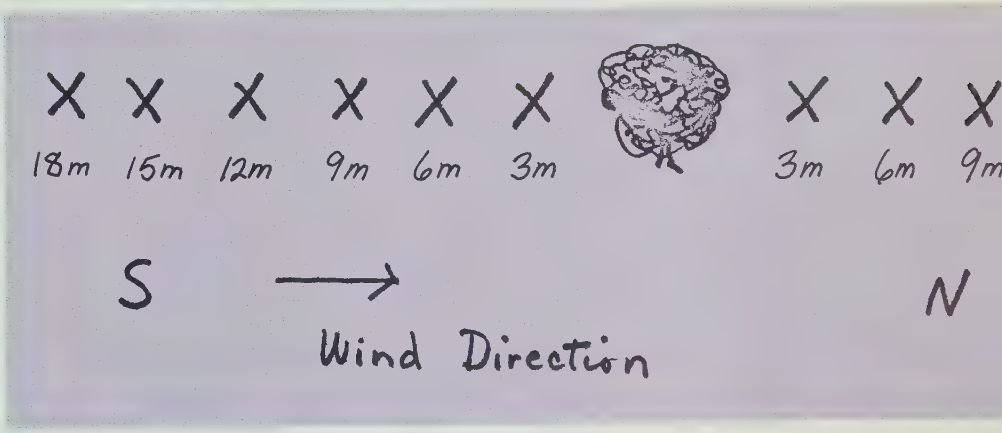
Where would you expect to find small animals when a cold wind is blowing?

Activity 4:

How does an object which the wind strikes affect wind velocity?

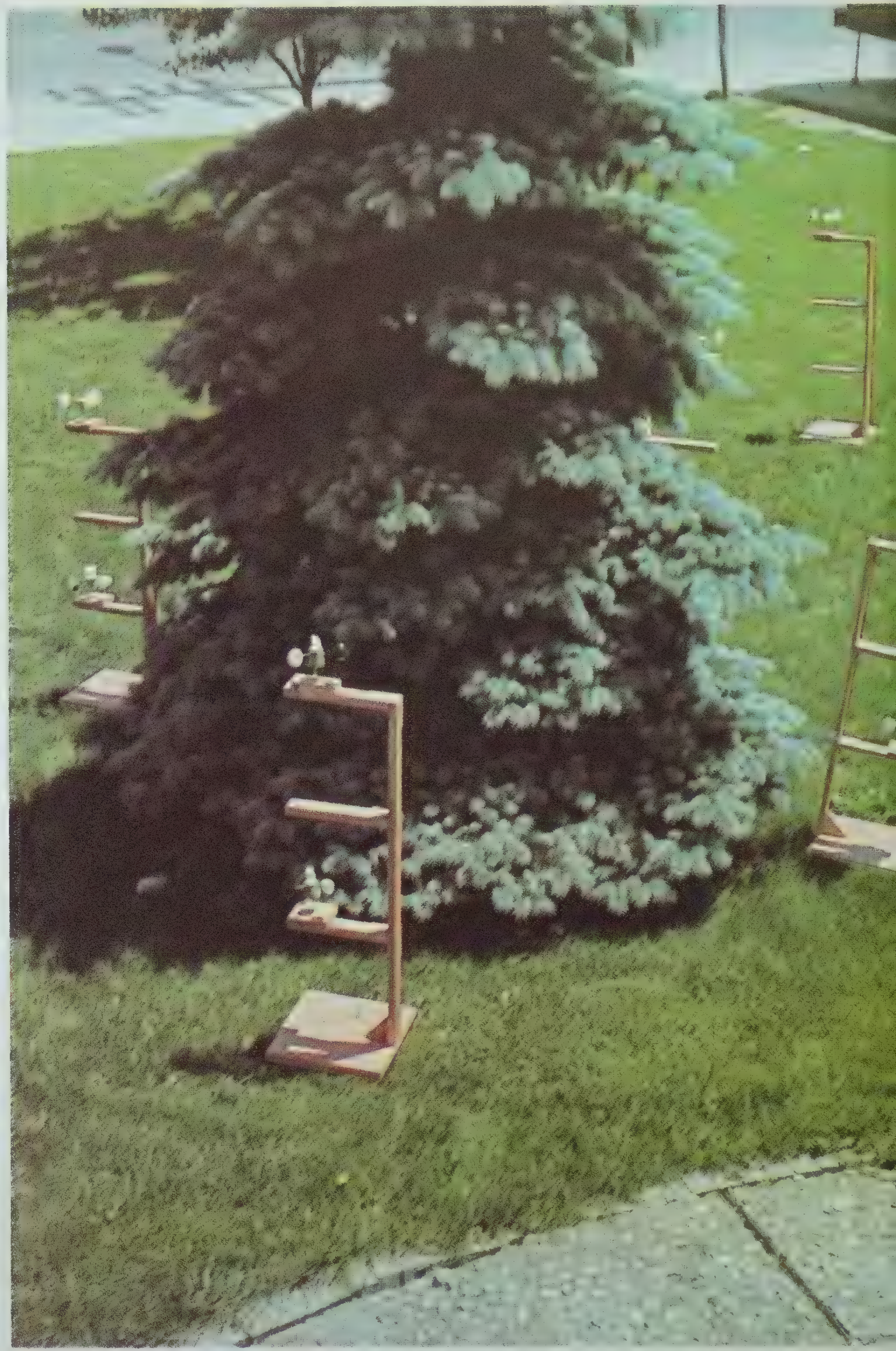
Select an object such as an evergreen tree, wall, building or small hill.

On a day when a steady wind is blowing, place anemometers and take readings at regular intervals along a straight line running in front of and behind the object. More anemometers could be placed at various locations around the object. Take your readings at ground level first and then use the stands from the previous activity. Better results could be obtained if as many readings as possible could be made at the same time.



Distance from Object	Wind Velocit
N 9 m	
N 6 m	
N 3 m	
N 0 m	
S 0 m	
S 3 m	
S 6 m	
S 9 m	

Which anemometers would indicate the same wind speed as those on the stand in the foreground?



Digging Deeper

At what locations were the same readings observed?

At what heights were the same readings obtained?

Is there any mathematical relationship between the wind velocity, height and distance for the readings which were taken in the same straight line that extended to windward and leeward of the object?

How would rocks, tall grass, fence posts or stumps affect the wind's velocity? How could your anemometer be placed at ground level when investigating these objects?

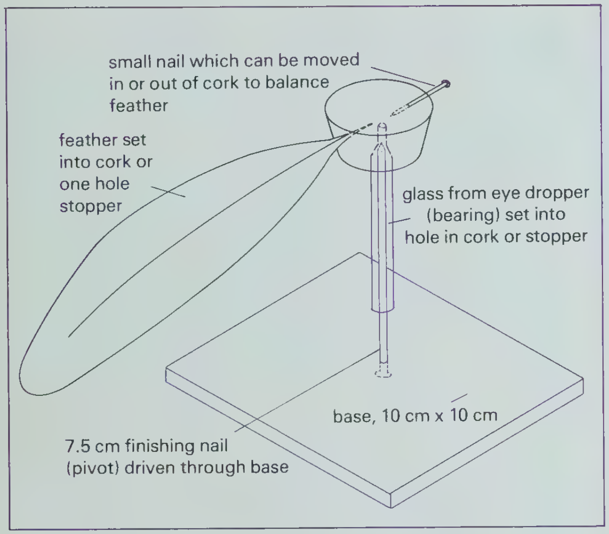
How would this information help to explain snowdrifts around snow fences, snow overhanging roofs and snow dunes around plants? Is there any similarity in the formation of snowdrifts and sand dunes?

Activity 5:

How can wind direction be measured?

The instrument often used to indicate wind direction is called a wind vane. You may recall seeing somewhat decorative versions of this instrument mounted on top of roof peaks or church steeples. A common but sometimes misleading name given to this wind device is weather vane.

In order to measure wind direction, a wind vane can be used along with a compass. When a north wind is blowing, the wind is travelling out of the


small nail which can be moved in or out of cork to balance feather
feather set into cork or one hole stopper
glass from eye dropper (bearing) set into hole in cork or stopper
base, 10 cm x 10 cm
7.5 cm finishing nail (pivot) driven through base

North but is actually moving in a southerly direction. In this case the wind vane would point in a northerly direction. Wind vanes show the direction from which the wind is blowing.

Construct three or four wind vanes similar to the one shown in the diagram.

Select a day when a steady breeze is blowing. Place the completed wind vanes on the ground in an open area such as a lawn or parking lot. Observe the behaviour of the wind vanes for two or three minutes.

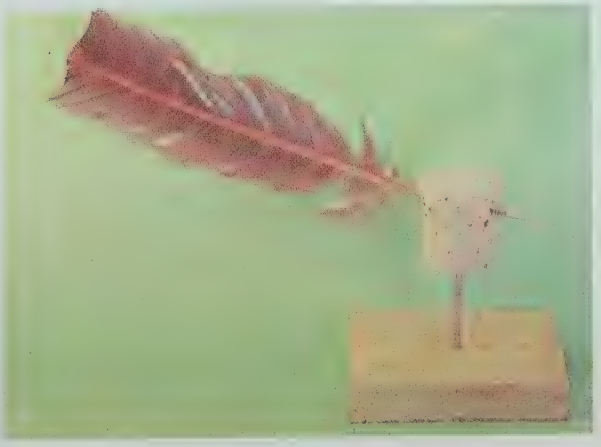
Digging Deeper

Which of the wind vanes pointed in the same direction? Which ones pointed in some other direction? What factors might account for any differences you observed?

Does the direction in which any one wind vane points remain the same for more than a few seconds? Why should

What would this type of "weather vane" tell about wind?

Some of the materials you could use to make a feather vane.



A completed wind vane might look like this one.

several readings be taken and then averaged when one or more wind vanes are to be used?

When using the anemometer, certain precautions had to be taken in order to obtain accurate results. To what extent do these precautions affect the use of wind vanes?

How could a compass be used with a wind vane to obtain the exact wind direction?

Activity 6:

How do surface objects affect wind direction?

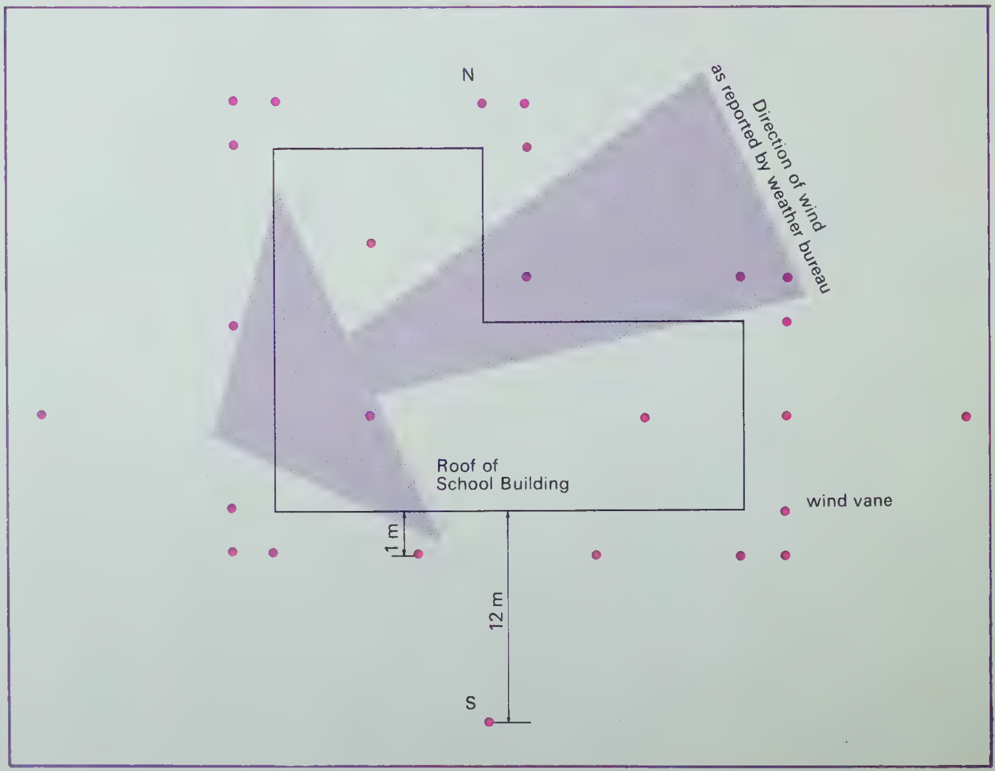
On a windy day, choose a building or wall around which a number of wind vanes could be set out. Place the wind vanes in such locations as the leeward side, the windward side, at the corners and possibly on the roof. Use stands to keep the wind vanes at a constant height above the ground. Try to place the stands at a uniform distance of 1 m or so from the object you chose. A few wind vanes might be placed at some distance from the building for purposes of comparison.

Map the area and plot the location of the wind vanes. Use arrows to show the direction of the wind indicated by each wind vane.

Digging Deeper

Which wind vanes pointed in the same direction? Which seemed to change direction frequently?

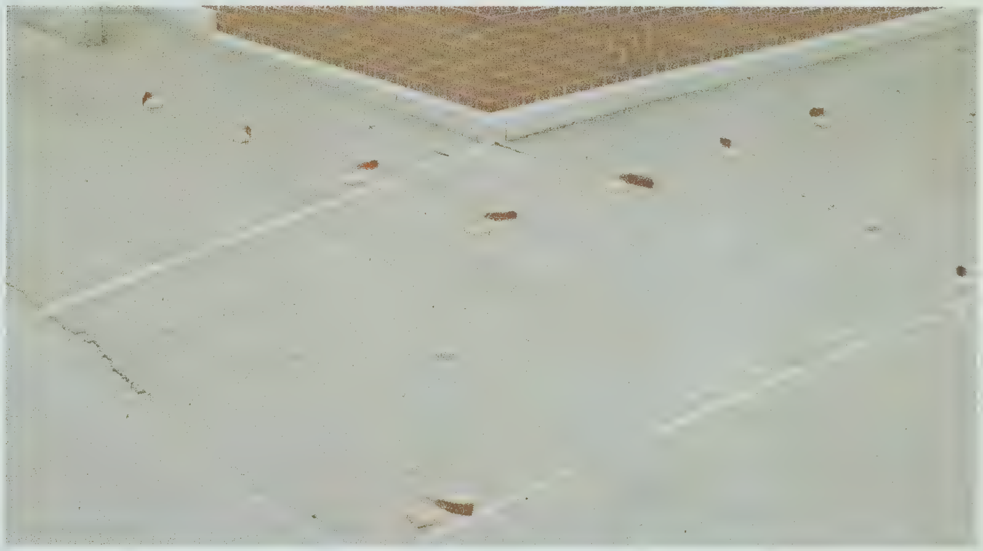
Jackie and Donna are fastening a wind vane to the arm of a stand.

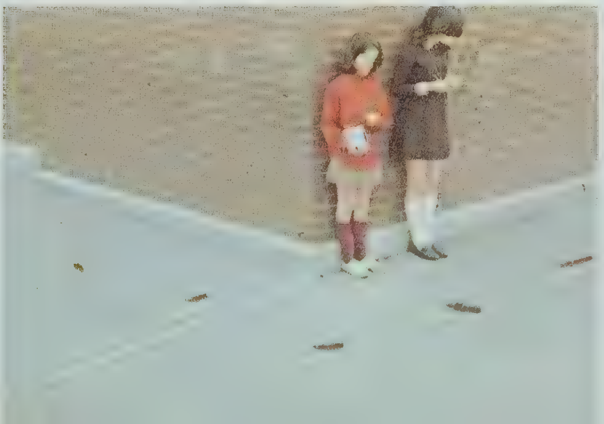


A compass is being used to help record the precise wind direction of each vane.

A metre stick is being used to help in the precise placing of some wind vanes.

What does the direction in which these vanes are pointing tell you about wind?





In which direction was the wind blowing when this photograph was taken?

These wind vanes are being used to investigate the wind pattern around a bush.

Several wind vanes can be used to map the wind patterns across a gulley or ditch.

Which wind vane directions agreed with the wind direction reported by the weatherman?

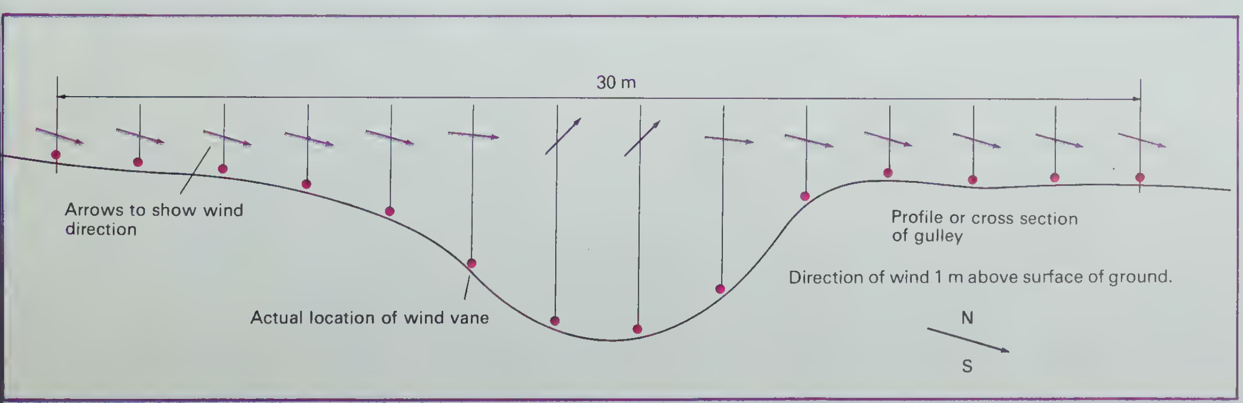
Why was it important to locate the wind vanes at the same height and distance from the object?

Would similar readings be obtained if the wind vanes were located 12 m instead of 120 cm from the object?

Would a similar set of wind directions be obtained if a small evergreen tree, a fence post or a large rock were used in place of the building or wall?

Branching Out

At equal intervals on the surface of the ground, place wind vanes in a straight line running across a ditch, a gully or down a slope. Observe the wind vanes for five minutes to determine the dominant wind direction. Use a wind vane and stand to find the wind direction 90 cm above the surface of the ground. Prepare a cross section map to illustrate what you discovered. Circles could show the location of the wind vanes. Use arrows to record the wind directions as shown by the wind vanes.


30 m
Arrows to show wind direction
Actual location of wind vane
Profile or cross section of gulley
Direction of wind 1 m above surface of ground.
N
S

Digging Deeper

Where was the greatest difference in wind direction observed? Which wind vanes pointed in the same direction?

Which wind vanes pointed in the same direction as the wind vane located 90 cm above the ground?

Why was it necessary to observe the wind vanes for five minutes before recording the wind direction?

Can you suggest other places where the wind direction might be affected?

Activity 7:

How does wind direction vary with the height above the ground?

Use the wind vanes and the stand you have already constructed. Attach the wind vanes to each level of the stand with elastic bands as you did earlier with the anemometers. You will need the help of a friend in order to read all of the wind vanes at the same time. The stand will help you to locate the wind vanes at regular intervals above the ground. Once again you may have to dig a shallow pit in order to place the lowest wind vane at ground level and use large stones to keep your stand from blowing over. You may also need a compass.

Choose a time when a steady breeze is blowing. Observe the wind vanes for a period of about 30 seconds. Decide in direction each wind vane points for most of this period. You could record the directions of the wind vanes every five seconds and then make your decision.

Devise a suitable method to record your findings.

Digging Deeper

Which wind vanes pointed in the same direction at the same time? Which did not? What would this seem to indicate about the nature of wind?

Would several stands with wind vanes located near each other in the same area produce the same readings? How could you find out?

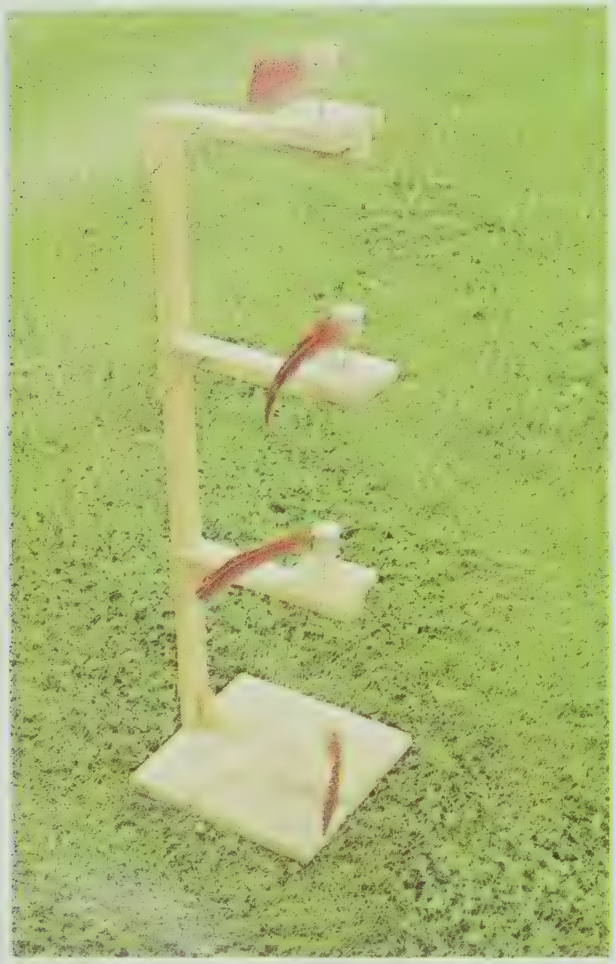
Would several stands with wind vanes give similar results if placed on bare ground, the lawn, the parking lot, a gravel road or under a tree?

What factors should be taken into account when deciding where to locate the stands in each area?

Which animal would be most able to use wind direction to help locate the presence of an enemy: a deer, a rabbit or a mouse?

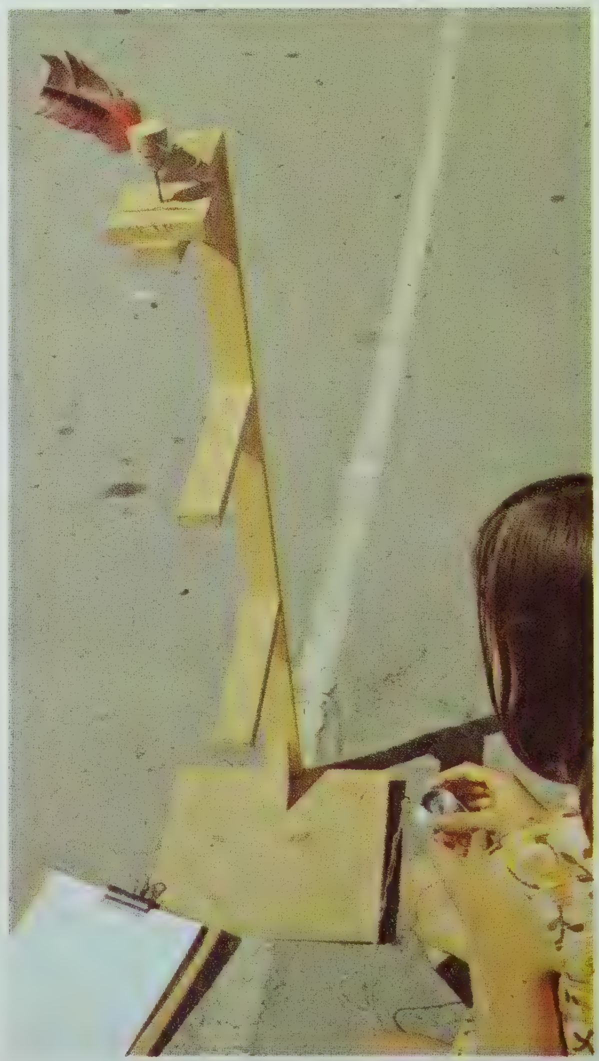
How would a wind of greater velocity change the behaviour of the wind vanes?

What instructions did the timekeeper give the other boys and girls that were helping her?



Several wind vanes are being used to examine wind patterns above grass.

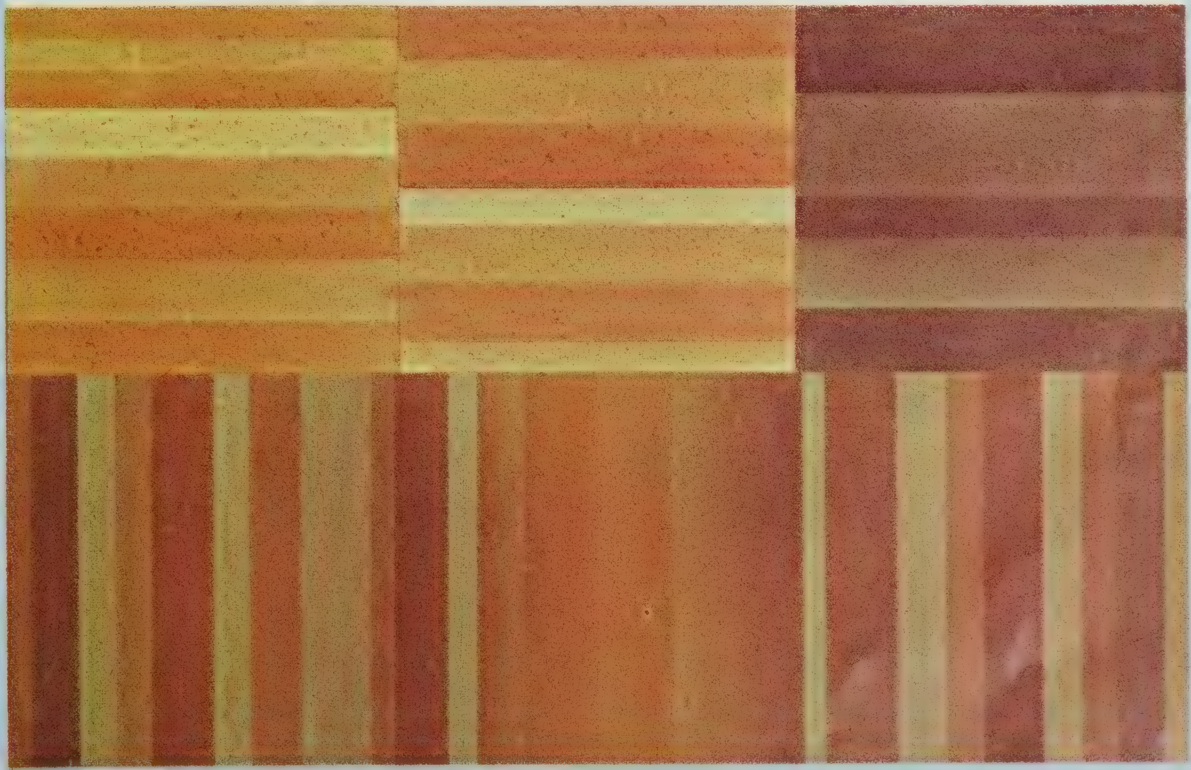
Kimberley is observing wind patterns 90 cm *above the pavement.*



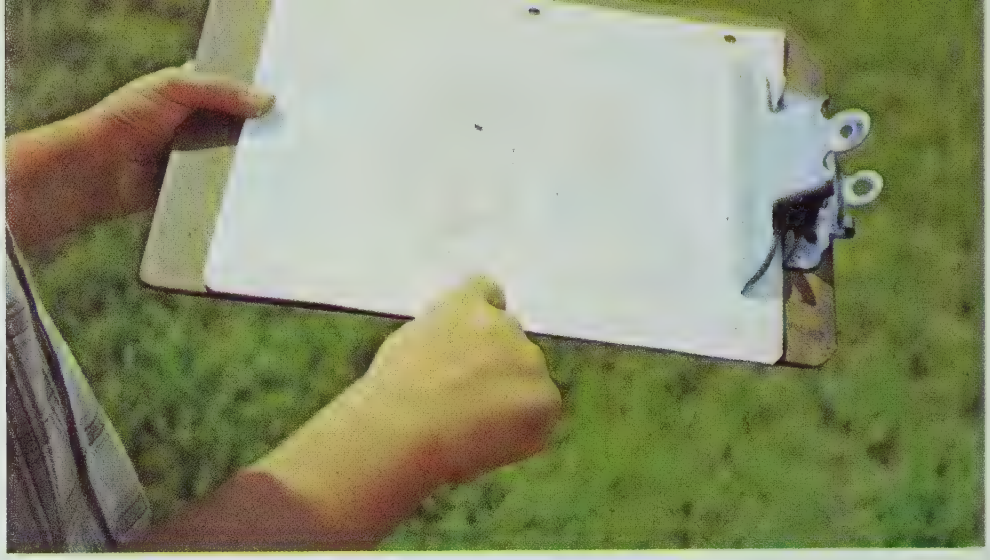
5

SOIL

IN A MINI-CLIMATE.



What does this finger test tell you about the size of soil particles?



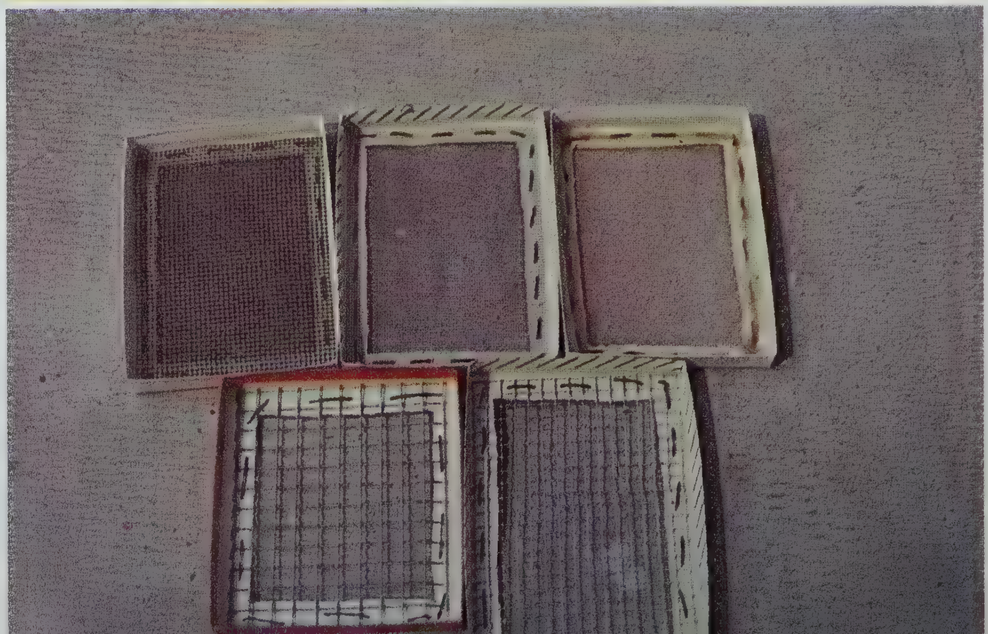
In this book a mini-climate has been described as extending from about 1 m above the earth's surface to 25 cm beneath it. The part of the mini-climate below the surface is much more difficult to observe than the area above it.

Soil contains many different materials that may be classified as solids, liquids or gases. Other things found in soil may be classified as living or non-living things. You could try some of the following activities to discover some differences in soil.

Activity 1:

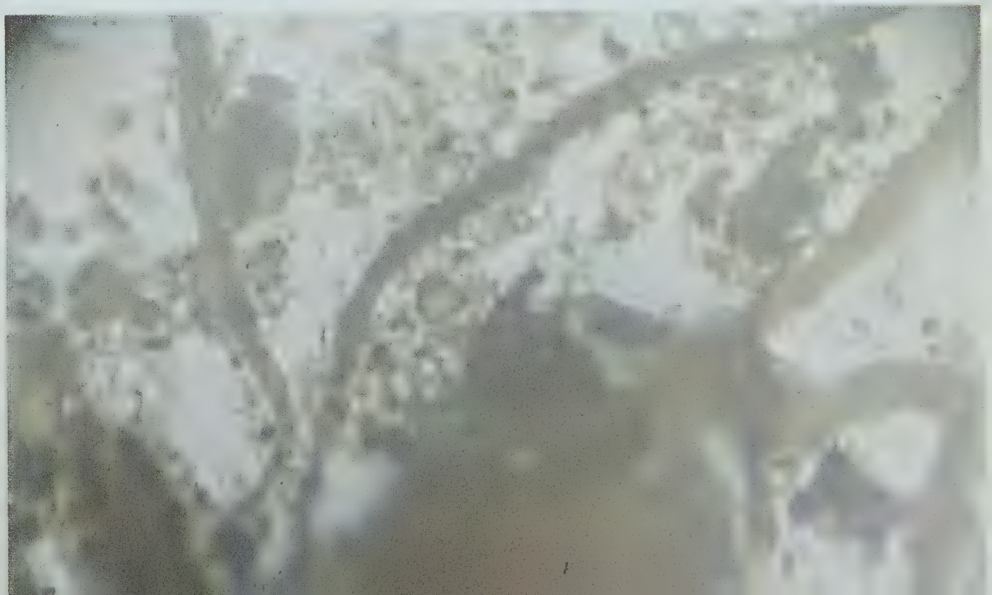
What is soil?

Place some soil on a piece of white paper. Look at the individual particles through a magnifying glass. Do they differ in size? Slide the loose soil into a container and examine the paper more closely by rubbing your finger along the surface. What does this activity tell you about the size of soil particles?



Ricky and Michael are sifting soil through different sizes of screening. Can you find screening material to make sieves like these?

Ricky is using a 50-power microscope to take a closer look at soil.
How did stringy materials get into the sample of soil shown at the bottom of the page?



Sift different samples of soil through a nylon stocking, or window screening. Are there different sizes of particles in each sample? Does particle size change from sample to sample? Carefully guess the mass of the soil that fell through the screen compared to the total mass of the sample? How would the results be different if a screen with larger or smaller holes was used?

Examine small amounts of soil under a microscope. Can you find any glassy grains through which light will pass? How can you tell that these small particles may have come from larger rocks? What types of rocks might have produced the darker particles in the soil? How can you find out?

Look for long stringy material under the microscope. Is the material living? What do you think it is? What is happening to it now? Where would you find soil that contains much of this material?

Collect jars of soil from different locations. Soak each one with distilled water to a depth of 3 cm above the soil level. Cover the containers and let them stand for two weeks. Study the water and soil solutions under a microscope. How many different forms of life can you find? Try to sketch them. You may have to examine several specimens of water before you discover any living things. Of what value are these living things to the soil?

Add a 200 g of soil to a container of water. What happens? What is in the soil that caused this action? Why is this material important to soil?

Find the mass of a container of freshly dug garden soil on an equal arm balance. Leave the sample on the scale for a few days. Does the scale remain balanced. What might have caused this change? Conduct another investigation to support your opinion. Try these activities with other soils.

From your activities you have discovered that there is more to soil than one would notice at a casual glance.

What Differences in Mini-climates Can Be Related to Soils?

Look for variations in the soils and surfaces around your schoolyard and the surrounding neighbourhood. Rub different soils between your thumb and index fingers. How does the texture of soils differ?

Do some soils appear to support more vegetation than others?

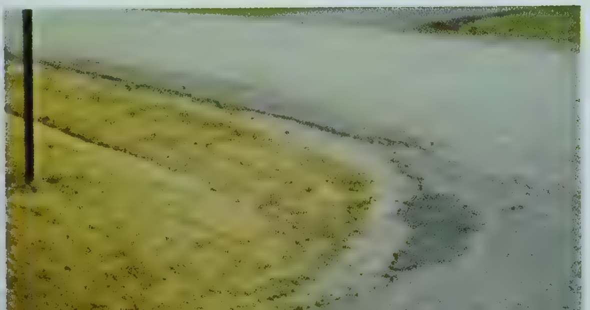
Are some lawns in the neighbourhood greener than others?

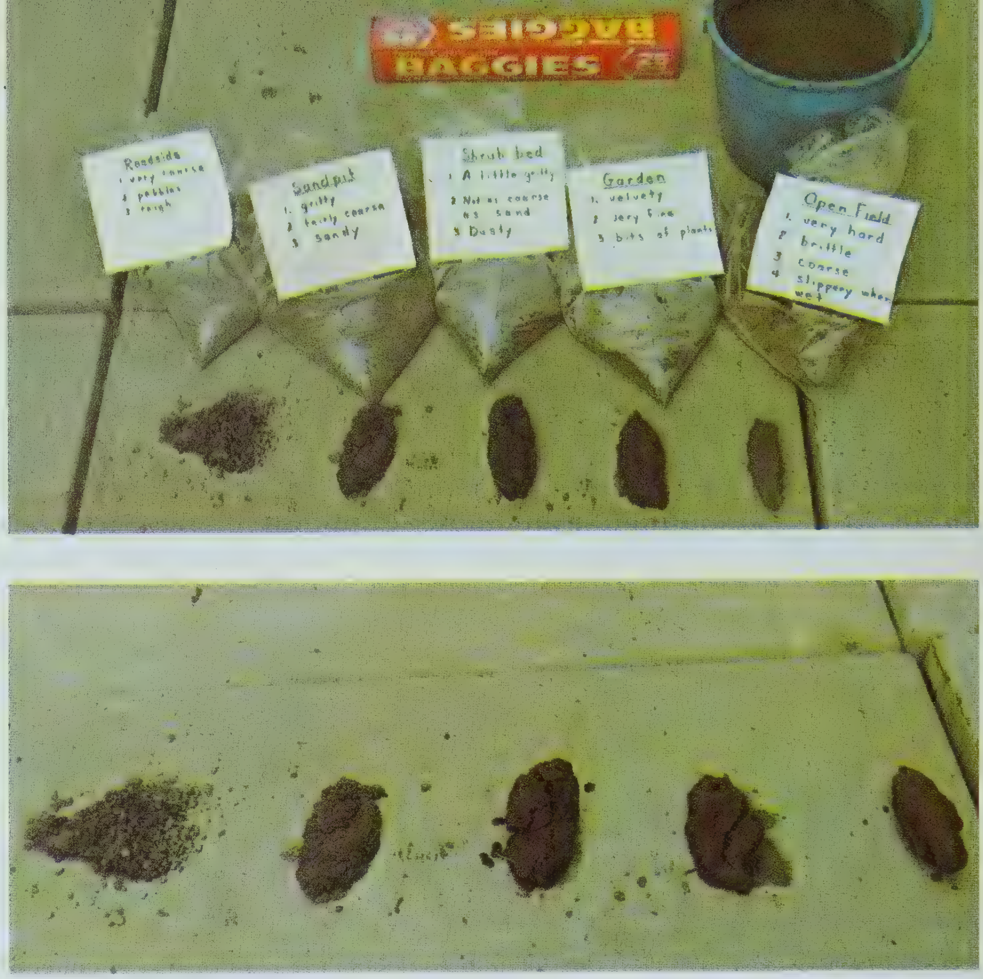
What colour differences can you find in soils?

Where does the soil seem to be very compact and hard? What places have looser soils?

What differences in soil temperatures can you feel with your hand?

The investigations of the above problems will lead you to interesting discussions. Perhaps you could enlarge this list with several questions of your own.





Compare these "snake" rolls to the soil texture chart to find the names of the soils.

Soil Texture Chart

	Texture	*"Snake" Rolls*
Gravel	Coarse, many pebbles	Will not roll
Sandy loam	Gritty, sandy particles	Will not roll
Sandy silt loam	Gritty, smoother than sand	Rolls a little bit, does not stay together
Silt loam	Velvety	Rolls but breaks
Silty clay loam	Not as brittle or sticky as clay	Rolls, has small cracks
Clay loam	Brittle, rough, able to be crushed when dry, sticky when wet.	Smooth, sticky, keeps shape well

How Are Soils Named?

You can learn much about soils by feeling their texture. Some of the following words might describe how they feel: coarse, gritty, velvety, slippery, harsh, sticky, floury. Perhaps you can think of good descriptive words to add to this list. Soils are often divided into four big groups, according to the quantity of different sizes of particles found in them. These classifications are gravel, sand, loam and clay. Silt, which is between sand and clay in particle size, is sometimes added to this list. Since loam contains sand, silt and clay, in different quantities, it is also named by its dominant ingredients. Clay loam or silty clay loam are examples. Soils are also named for the place where the soil was first studied, for example Ontario silt loam. You might like to name your samples according to the places where you find them, e.g. lawn clay loam. It is interesting to note that not all soils of one general type are alike in all regions. Clays can be reddish in one area and brown a few miles away.

Activity 2:

How can soils be classified?

In plastic bags collect samples of soil from different areas around your school.

Feel the texture of the soils by rubbing a little of each sample between your thumb and index finger. On each container, write a few adjectives that describe how the sample feels.

Sprinkle water on each sample of soil so that the particles are moist yet not too wet.

Roll each moist sample between your palms to make a "snake-like" roll about 3 cm across. You may need to experiment with the amount of water to add to the sample before it is wet enough to roll.

Group the samples according to how well they keep their shape.

Place the original container beside each "snake" roll.

Use the soil texture chart to help you to classify each sample.

Digging Deeper

What different types of soil did you find in your neighbourhood?

Why do you think that all the soil types might not be represented in your area?

Describe the soil particles that made the smoothest "snake roll."

In which soil would drainage be best? poorest? Why?

Put some soil from different places into test tubes so that the soil comes up to the same level in each.

What will happen when an equal weight is placed in each test tube?

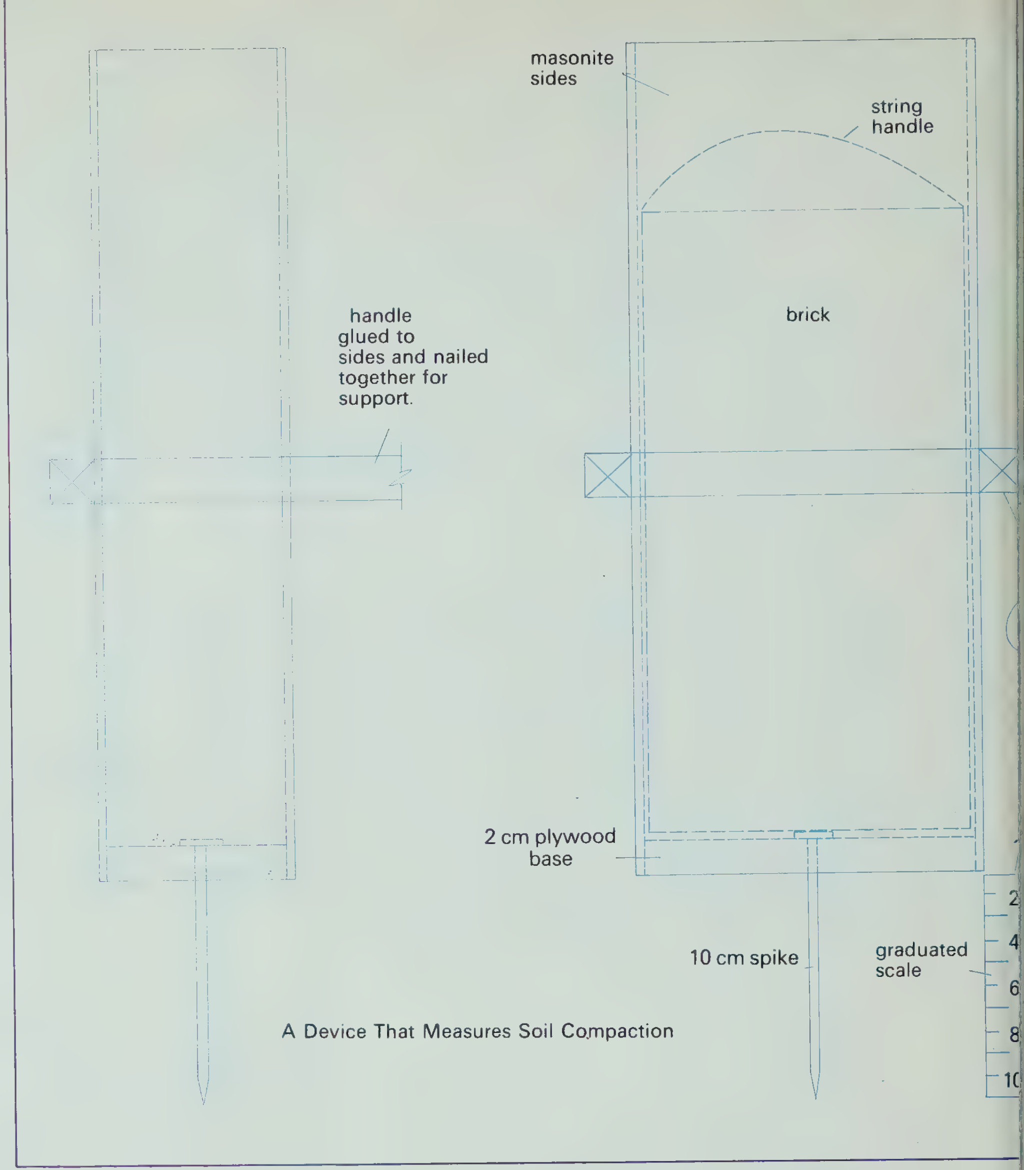
The Hardness of Soil

One of the more easily observed differences among soils is the looseness or compactness of the soil. This compaction varies from area to area.

Some soils support a considerable population of burrowing animal life that makes a great many tunnels or holes in the soil. Other areas are consistently trampled, causing the soil to be quite compact. The amount of moisture, the type of vegetation, the frequency of cultivation and the size of soil particles are other factors which affect the soil compaction.

What differences in soil compaction would you expect to find in the areas that these boys are studying?

Here is a device that you could make to measure the compaction of soil particles in a mini-climate.



A Device That Measures Soil Compaction

Activity 3:

How does the compaction of soil vary in different areas?

The following are some suggestions to help you put this device to its best use:

(a) Drop the brick in the soil compaction tester from exactly the same height for each test.

(b) Three drops of the brick make up one test.

(c) Use the scale attached to the device to measure the distance between the surface of the soil and the bottom of the shute. The reading on the scale will tell you how much of the spike entered the soil.

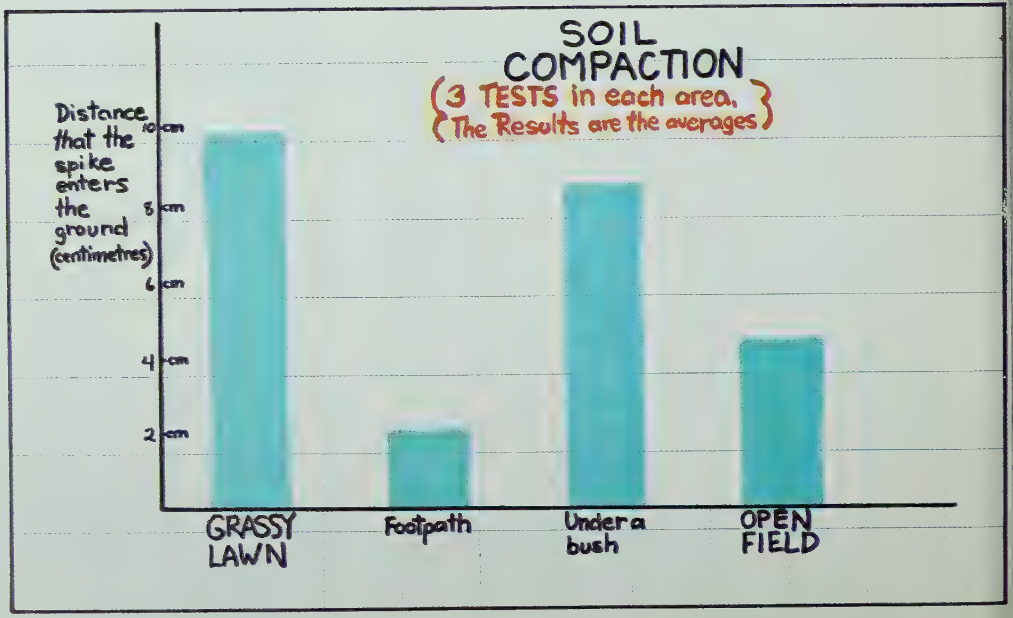
(d) Test each area five times and average the results.

(e) The same person should drop the brick for every trial while another student holds the device.

(f) Try to complete all tests on the same day under the same weather conditions.

Test the soil compaction in some of the following areas: a grassy lawn, a well-worn footpath, an open area, under a bush, under a tree, on a slope, in a hollow.

Transfer your field records to a suitable chart or graph.



What factors might have caused a low soil compaction in this lawn and a high compaction in the footpath?

Digging Deeper

In which area was the soil most compact? least compact?

What explanations can you suggest for the differences in soil compaction?

How would the soil compaction of one area change after several days of wet weather or during a very dry spell?

On the basis of the information that you collected, which of the following areas will have the greater compaction: a forest floor or a meadow with tall grass? Explain your choice.

Branching Out

Does soil compaction affect the life in a mini-climate?

Select two areas in your lawn: one which has been heavily trampled and the other which has received little traffic.

Test the soil compaction in each area. How do they differ?

Measure plots of ground that are 25 cm square, in each of the two areas. An easy way to measure the plots is to make a frame using a coat hanger. Bend the coat hanger into a 25 cm square with a pair of pliers. You can measure the plots by dropping the frame on a typical section of each area.

Plant Life:

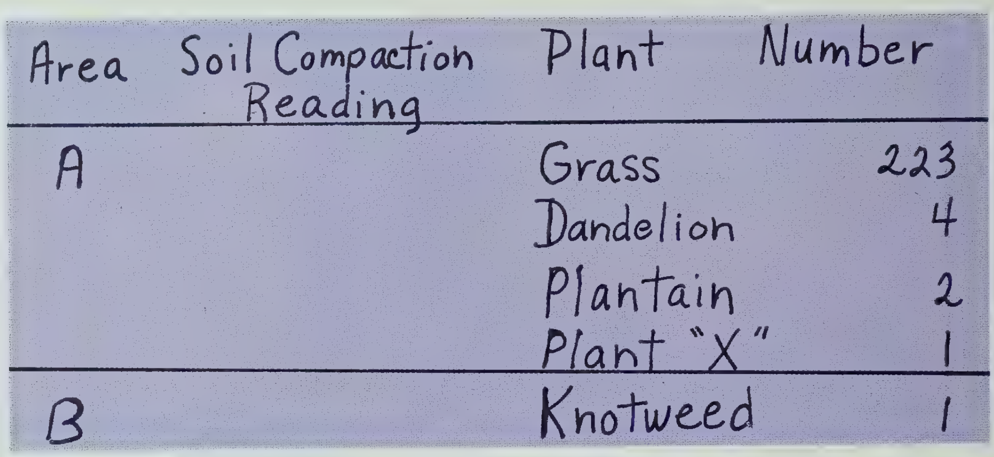
Find the number of plants in each plot in the following manner:

(a) Count the number of different kinds of plants within the frame;

How can you use a wire frame to help you find a good sample of living things in an area?

(b) Count the number of each kind of plant within the frame.

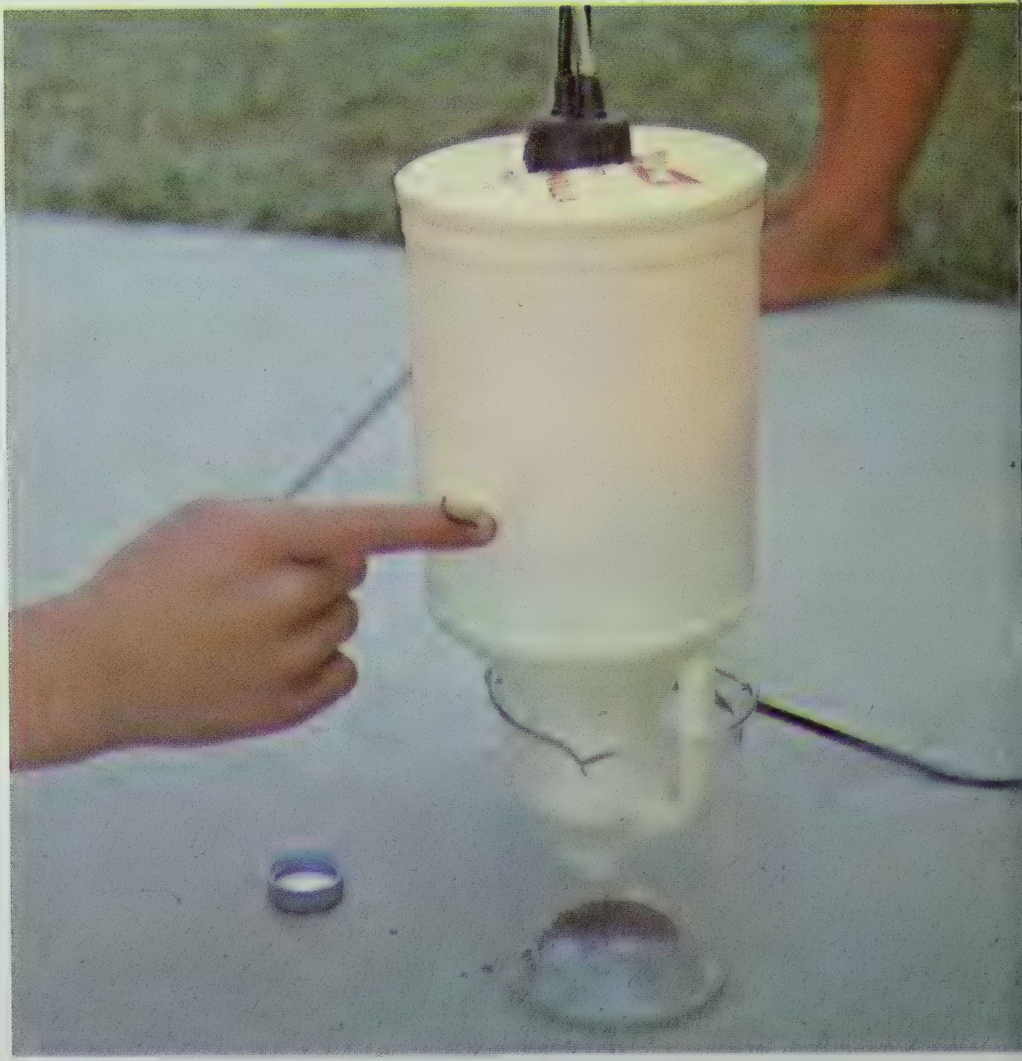
It is not necessary for you to be able to name each plant. You might label unknown species with a letter and try to identify them later by taking a sample to your classroom and referring to a resource book.



Area	Soil Compaction Reading	Plant	Number
A		Grass	223
		Dandelion	4
		Plantain	2
		Plant "X"	1
B		Knotweed	1

Small Animal Life:

The following is a device that can be used to separate "creepy crawlers" from soil. You might make one to find the kinds and amounts of small animals that live near the surface of soil.



You might follow these suggestions for using the separator.

(a) Remove the top 2 cm of soil from each of the 25 cm square plots.

(b) Place all of the vegetation, litter and soil into a plastic bag for transportation to the classroom. It is important to maintain the moisture content of this material.

(c) Carefully place some of the litter and soil on the screen in the separator to avoid losing material through the mesh.

(d) By attaching the cover and turning on the light, any small animals that are present will be driven down to the collecting jar.

(e) Classify and count the animals collected.

Area	Soil Compaction Readings	Animal	Number
A		Centipede	5
		Millipede	4
		Beetle "X"	2
		Sowbug	1
B		Red Ants	45

Digging Deeper

What relationships can you find between the living organisms on or in the soil and the compaction of the two areas?

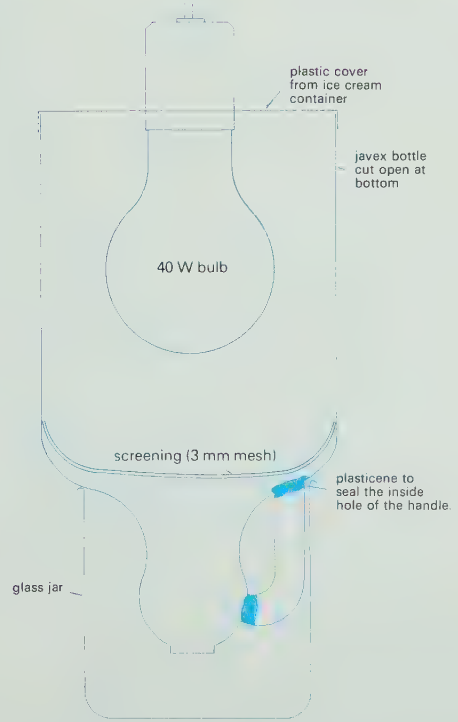
Would different plots in the same mini-climates yield similar results?

Can you predict the types and numbers of living things that might be found in the other areas that you tested in Activity 3?

Do you think that you have discovered all of the animals in your soil sample?

The Ability of Soil to Absorb Moisture

Porosity (po·ROZ·i·tee) refers to the ability of a soil to absorb moisture. Well-drained soils allow water to easily pass through them until the moisture reaches the water table. (Find out what is meant by "the water table.") Poorly drained soils hold moisture in the ground or on the surface. What factors might affect the porosity of the soil?


plastic cover from ice cream container
javex bottle cut open at bottom
40 W bulb
screening (3 mm mesh)
plasticene to seal the inside hole of the handle.
glass jar

"Creepy Crawler" Separator

Does soil compaction influence the drainage of soils? What effects will well-drained and poorly-drained soils have on living things? Will porosity affect the temperature of the soil?

Activity 4:

What differences in soil porosity can be found in some of the areas around your school?

In order to compare the results of porosity with soil compaction, you might choose areas that you tested in Activity 3.

In each area select a place that fairly represents that area. Remove both ends of a soft drink or juice can and press it into the ground to a depth of 5 mm.

Since water will be needed to test soil porosity, you may find it convenient to transport the water in a discarded plastic milk bottle or a similar container.

Pour the same amount of water into each of the cans that have been pressed into the soil. How much time is required for the soil to absorb the water in each case?

You might make one or two practice trials in order to answer the following questions which will help you to perfect your method.

(a) When should you start timing?
(b) What is a reasonable amount of water to use?
(c) How should the water be poured?
(d) What would be the best timing device: a stop watch, your pulse, an egg timer, your watch?
(e) When should you stop timing?
(f) Will you find more accurate results by testing the soil porosity of each area several times and taking an average?

You might like to prepare a graph to show your findings.

Digging Deeper

Which soil was most porous? least porous?

Refer to your records for soil compaction and porosity. Is there any relationship between them?

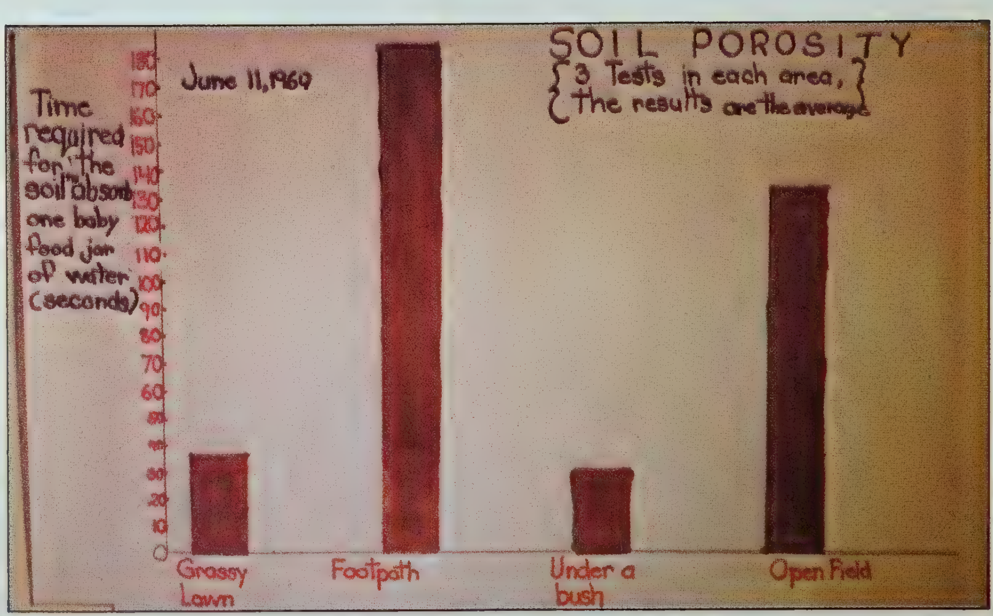
Why is it important that the activities for compaction and porosity be completed on the same day and under the same conditions?

Where would you expect to find the water table for each of the areas that you tested?

How would the soil temperature vary if two areas received the same amount and degree of sunlight but one had a high soil porosity while the other's porosity was low? What other factors might have influenced the soil temperature?

Are soils with small grains more or less porous than soils with larger particles? Why?

Can you find a relationship between soil compaction and porosity in the areas that were studied?



Water
CONTAINER
AREA
Open field
Lawn
Foot path

Chemical Differences in Soil

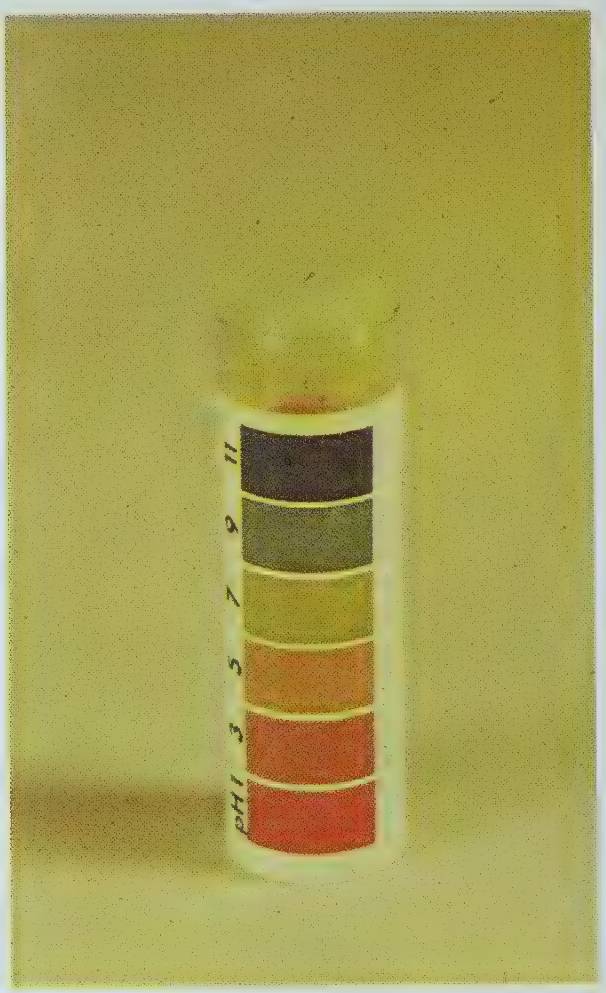
You have been studying the physical characteristics or properties of soil such as particle size, compaction, and porosity. Soil has chemical properties, too. One chemical difference in soils is the difference in soil acidity. The amount of acid in soil is very weak, but it can be measured with pH or hydrion (HYD·ree·on) paper.

pH paper is available at a reasonable cost from science supply companies. The scale on the dispenser or vial indicates the amount of acid in a solution that is being tested. This is done by comparing the pH paper that has been tested to the colour chart which is graduated within a possible range of 1 to 14. Seven is the neutral point on the scale. Five and six represent mildly acid readings while lower numbers show a greater amount of acid in the solution. Numbers from eight up indicate greater amounts of alkaline (AHL·kah·lyn) material or a complete lack of acid.

Test the pH of some common household materials such as milk, vinegar, water, coffee, soft drinks, cleaning fluids, detergents, starches, Alka Seltzer, tea or any other solutions that you might find. Did you find any difficulty in comparing the tested hydrion paper to the colour chart to find the pH value? How much paper do you need to use for each test? How much time is needed for the hydrion paper to react with a solution?

Activity 5:

What differences can you find in the acidity of soils around your school?



What colour indicates a neutral pH? acid? alkaline?

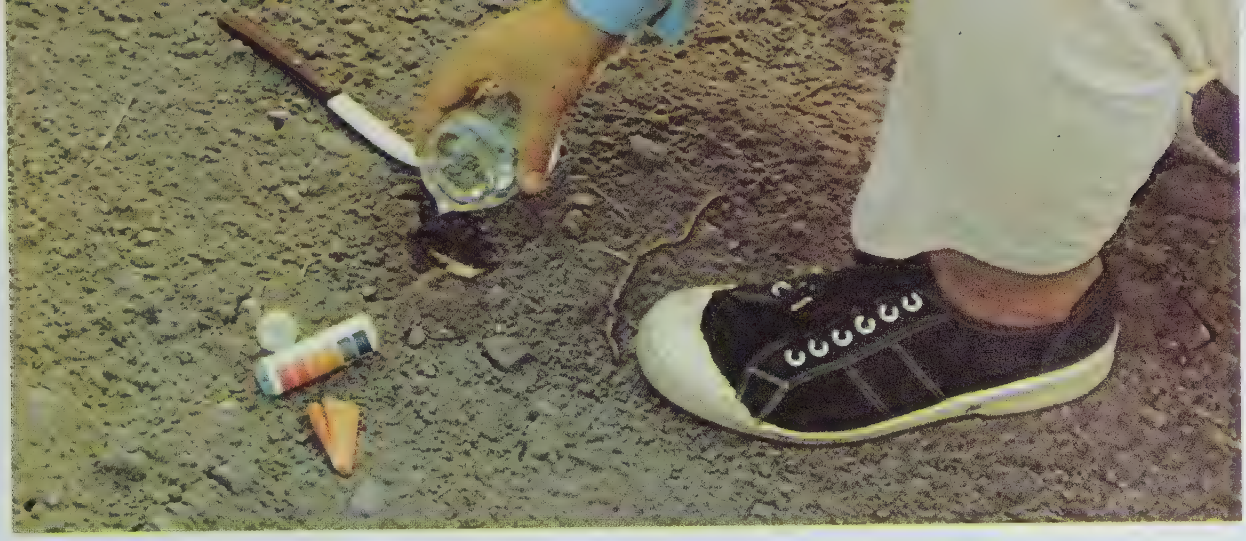
Collect samples of soil from several different areas around your school.

Moisten each soil sample with distilled water. Test each sample by setting a piece of hydrion paper into the moist soil. A knife edge might be used to make a wedge in the soil. Let the paper remain in the soil for a few seconds. Compare the colour of the paper with the colour chart on the pH dispenser.

If you can obtain pH paper with a range from 5 to 9 you will obtain clearer differences in soil acidity.

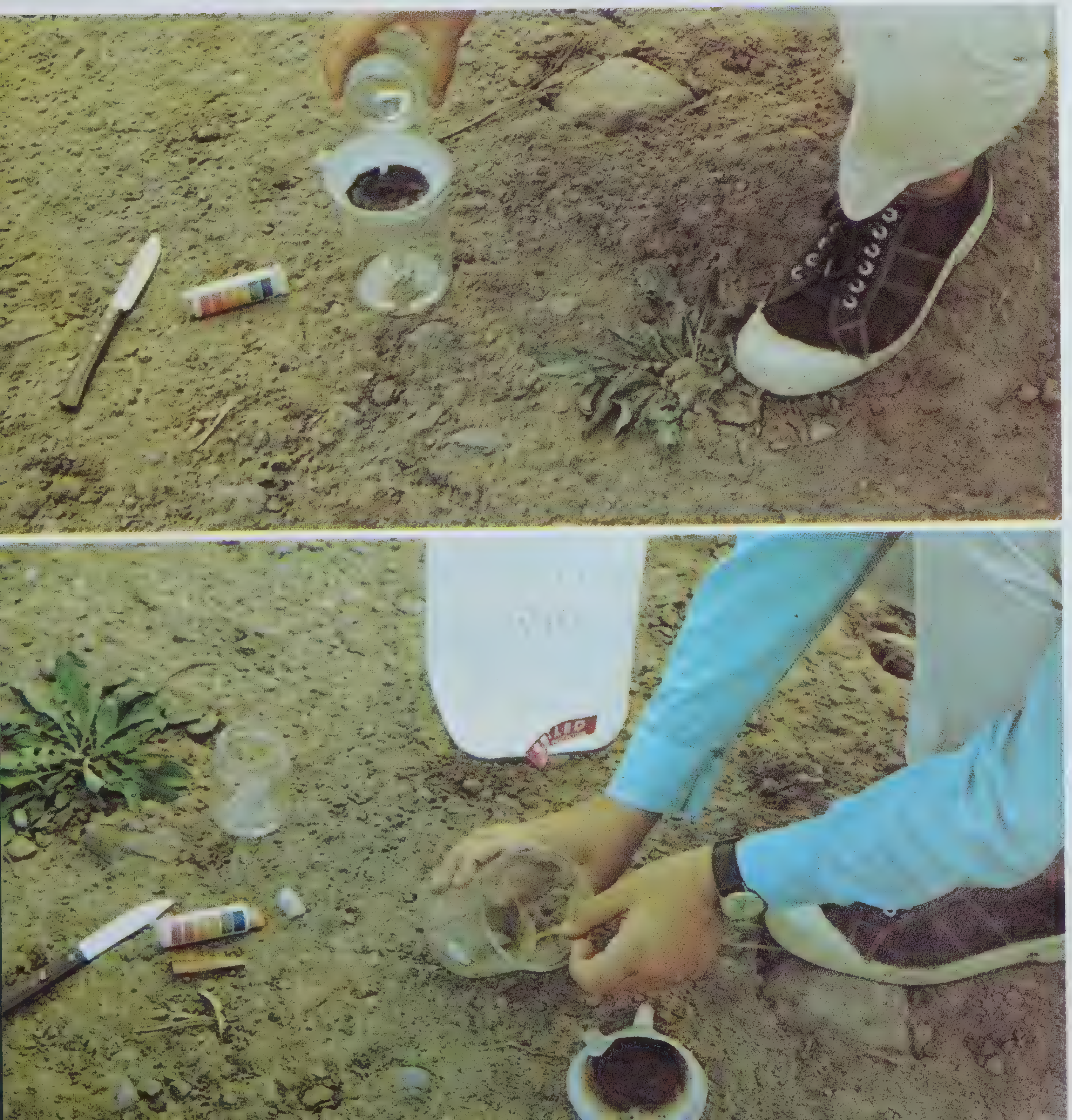
Take several tests in each area to find an average reading that can be recorded.

Another way to measure pH is to place the soil sample in a funnel fitted with filter paper. Pour some distilled water over the soil and collect the "run-off" in a container under the funnel.



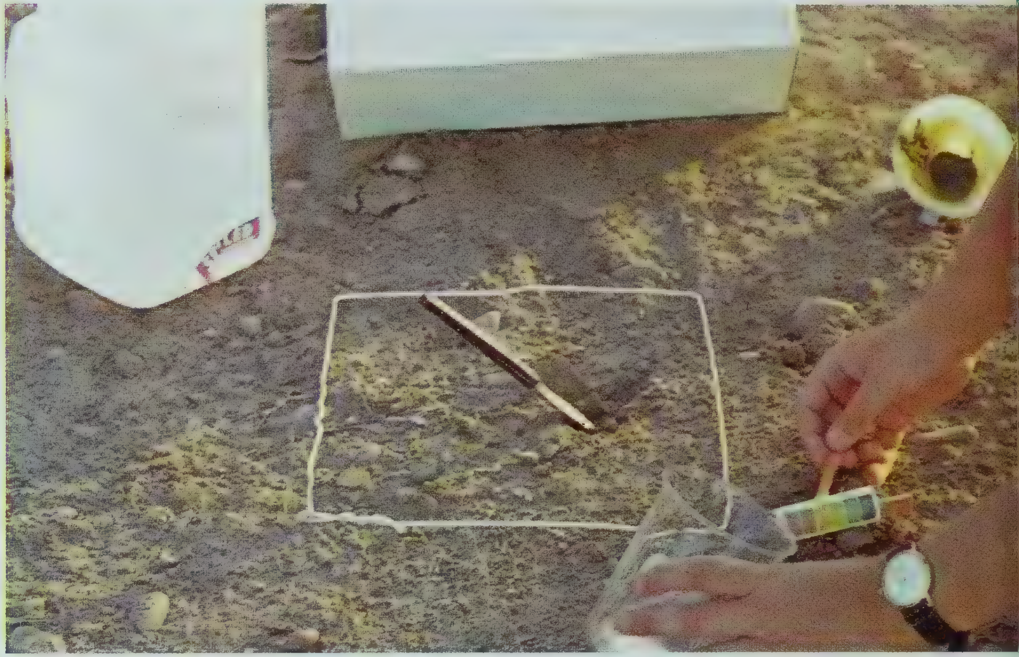
Method 1

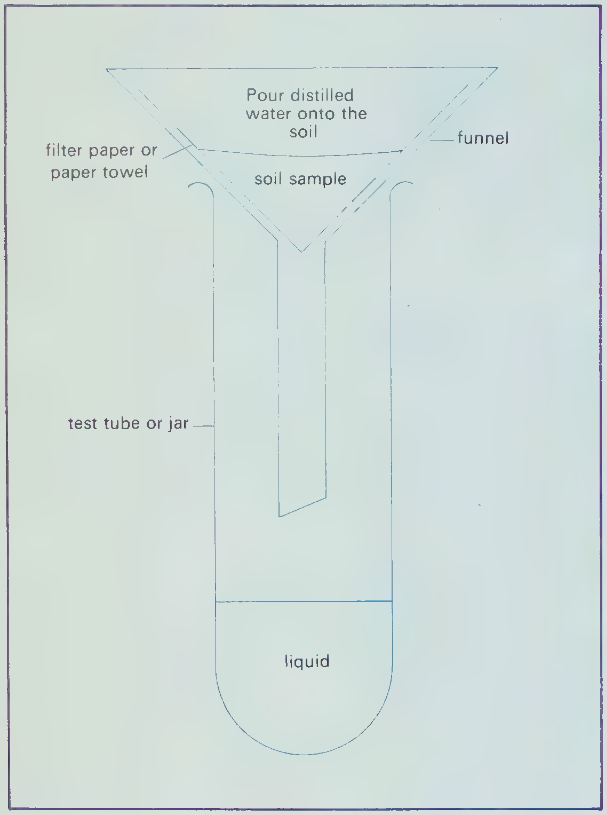
These photographs demonstrate two ways of finding the pH of soil. Which method is better?



Method 2

How has the pH of this soil changed from Wednesday to Friday?




Pour distilled water onto the soil
funnel
filter paper or paper towel
soil sample
test tube or jar
liquid

Place the pH paper in the liquid collected at the bottom of the container. Compare the results obtained by this method with the results obtained by the method described.

Digging Deeper

Which soil was the most alkaline? the most acid? a neutral soil?

What was the range of the soil reactions?

How did most of the soils react?

What pH readings would you find in a swamp? in beach sand? in a coniferous forest floor? in a deciduous forest floor? in a cultivated field?

From your study of these areas, what things might affect the pH of soils?

Activity 6:

How can the acidity of a soil be changed?

Measure a plot in a garden and find the pH of its soil. Record your information.

Add about 200 g of lime by mixing it well into the soil. (Many secondary schools and athletic associations use lime to mark their playing fields.)

Water your plot.

After a few days test the acidity of the soil again and record your results.

Digging Deeper

How did the addition of lime change the pH of the soil?

By how much did the soil acidity change?

Will twice as much lime cause a similar change in the soil's pH?

Why do farmers sometimes place lime or limestone on fields before seeding?

How would the addition of a fertilizer or manure affect the acidity of a soil?

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Appendix

PERCENT OF RELATIVE HUMIDITY—°C

Dry Bulb Temp.	Temperature Difference between Dry Bulb & Wet Bulb (°C)																																							
	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0
°C	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
40	100	98	97	95	94	92	91	89	88	87																														
39	100	98	97	95	94	92	91	89	88	86	85	84	82	81	80																									
38	100	98	97	95	94	92	91	89	88	86	85	83	82	81	80	78	75																							
37	100	98	97	95	94	92	91	89	88	86	85	83	82	81	79	78	75	72	69																					
36	100	98	97	95	93	92	90	89	87	86	85	83	82	80	79	78	75	72	69	66	63																			
35	100	98	97	95	93	92	90	89	87	86	84	83	82	80	79	78	74	71	68	66	63	61	58																	
34	100	98	97	95	93	92	90	89	87	86	84	83	81	80	79	77	74	71	68	65	63	60	58	55	53															
33	100	98	97	95	93	92	90	88	87	85	84	83	81	80	78	77	74	71	68	65	62	60	57	55	53	51	49													
32	100	98	97	95	93	91	90	88	87	85	84	82	81	79	78	77	73	70	67	65	62	59	57	54	52	50	48	46	44											
31	100	98	96	95	93	91	90	88	87	85	83	82	81	79	78	76	73	70	67	64	61	59	56	54	52	50	48	46	44	42	40									
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5	100	97	93	90	87	84	81	78	75	72	70	67	65	62	60	58	53	48	43	39	35	32	29	26	23	21	19	17	15	13	12	11	10	9	8	7	6	6	6	5
4	100	96	93	89	86	83	80	77	74	71	69	66	63	61	59	56	51	46	41	37	33	30	26	24	21	19	16	14	13	11	10	9	8	7	6	5	5	4	4	3
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Glossary

Absorption: The ability of a substance to take in and retain another substance. e.g. Some soils can absorb moisture better than others.

Acetate: A transparent plastic-like material that is used on an overhead projector as a writing surface.

Acid soils: Soils that are weakly acid. They are often called sour soils.

Air drainage: Air that has cooled, contracts and becomes heavier and therefore flows downhill.

Alkaline soils: Soils that contain materials that counteract any acids that may be found in the soil. They are often called sweet soils.

Almanac: A book or table containing a calendar of days, weeks and months, with the times of the rising and setting of the sun and moon, eclipses, hours of tides, weather observations, etc.

Anemometer: A wind speed indicator that measures how fast the air is moving. Cup type—measures wind speed in revolutions. For construction see page 42. Fan type—measures wind speed on an arbitrary scale as the wind forces a moveable arm up the scale. For construction see page 45.

Anemometer stand: A vertical wooden structure with ledges so that wind speed and/or direction can be measured at different heights in a mini-climate from ground level to 90 cm. For construction see page 47.

Angle: The space between two straight lines meeting at a point, measured in degrees (°).

Arbitrary: A decision or rule made by one or more people for a particular purpose.

Atmosphere: The blanket of air surrounding the earth. 99% of the atmosphere is within 30 km above the surface.

Assumption: Something taken for granted or without proper proof.

Average: A good way to ensure greater accuracy. Add all of the answers obtained and divide the total by the number of answers that were added.

e.g. The average of 8, 10, 12 is $\frac{30}{3}$ or 10.

Beaufort Scale: A method of estimating wind speed by observing the movement of smoke, leaves, branches, flags, telephone wires, etc. See page 46 for chart.

Behaviour: How something acts.

Calibrations: The graduations or markings on a measuring device that make up the scale.

Carbon dioxide: CO_2, a gas in the air given off as a waste material in respiration by animals, and used by plants in the making of food and cells.

Celsius: A scale used in the metric system of measurement to measure temperature. The boiling point of water is 100°C and the freezing point of water is 0°C.

Classification: The grouping of objects or materials together on the basis of similar characteristics.

Clay: A type of soil with very fine particles compacted closely together, brittle when dry and sticky when wet.

Cobalt chloride paper: Blotting paper soaked in cobalt chloride solution and dried; used to detect the presence and degree of moisture; turns to shades of red with moisture and shades of blue with lack of moisture. See page 27 for information on how to make cobalt chloride paper.

Compaction: The degree of looseness or compactness of soil, e.g. soil compaction. To measure soil compaction see the device on page 70.

Control: A standard of comparison used for observing the results of an experiment. e.g. When testing the effects of colour on the temperature of soil, one plot is coloured white, another black and another is left natural as a control plot. Temperatures are taken in the three plots and compared.

Cross section map: A profile or side view of an area.

Cubic metre: A unit of volume measuring a space one metre long, one metre wide and one metre deep.

Cultivation: The preparation of land for the planting of crops.

Data: A collection of measurements or facts to be used as a basis for studying, interpreting and concluding.

Degrees: The graduations on a thermometer, compass, and protractor that are the units for measuring temperature, direction and angles.

Device: A tool designed for special use, e.g. a cog psychrometer is used to find the relative humidity in tall grass, in an animal burrow, in tree leaves, etc.

Dew: A form of moisture caused when water vapour is cooled and condenses into droplets, e.g. on a car or grass in the early morning.

Diameter: The length of a straight line through the centre of a circle to its outside edges.

Distilled water: Water purified by heating to water vapour and cooling to condense; available at most drug stores.

Dominant wind: The direction from which the winds are most commonly blowing at a particular time and place.

Drainage: The flowing or draining of water or other substances through or over material.

Ecology: The study of the interrelationships of plants and animals and their environment.

Equal arm balance: An instrument with two pans on the opposite sides of a sensitive fulcrum or balancing point so that the unknown mass of a substance can be balanced or compared to the known mass of another object or set of masses.

Estimation: A fairly accurate guess at the measurement of something by using past experience or some other known information.

Evaporation: The process of taking out moisture. In the case of water, the changing of liquid water into a gas called water vapour—part of the water cycle.

Evaporimeter: A device used to measure the rate of evaporation in an area. For construction see page 39.

Experiment: The procedures of investigating a specific problem to discover accurate data and make meaningful interpretations.

Extreme: The farthest points at both ends of a scale.

Factor: One of the causes of a particular result. e.g. One of the factors causing a high soil compaction is trampling.

Field of vision: The area that can be viewed through a microscope, which depends on the power or strength of the lenses used.

Field records: The information recorded while investigating a problem outside. Often a clipboard that can be suspended with a string around the neck or a pocket size notebook are used.

Forest duff: The natural debris and litter on a forest floor that might include decaying leaves, needles, and other organic materials.

Glass bearing: A balancing point made of a piece of glass tubing that has one end sealed by heat so that the tubing or bearing can be turned on a nail with very little friction or resistance. It is a very important part of a cup anemometer or a wind vane.

Graph: A type of record or representation on a surface lined horizontally and vertically and showing the manner in which one quantity or quality depends upon or changes with another factor.

Habitat: The natural home or environment for a particular plant or animal.

Humidity: The amount of moisture or water vapour which is in the air at any given time.

Hydrion paper: A type of paper (chemically treated) that changes colours to indicate whether a solution such as soil and distilled water is acid, basic or neutral. A colour chart on the dispenser or vial shows values from 1 to 11 or other ranges. It can be purchased reasonably from a science supply company. It is also called pH paper.

Instrument: A tool that is used to do work or help in an investigation, such as a measuring device.

Intensity: The amount of light in an area measured by a light meter in lux or on an arbitrary scale.

Interval: An amount of time or distance between two events or points.

Invertebrate: An animal without a backbone or interior skeleton system.

Investigation: An experiment to solve a problem scientifically by collecting accurate data and using it to make meaningful interpretations.

Leaf litter: The natural debris and material that might be found on or near the surface of soil.

Leeward side: The side of an object, a mountain, hill, slope, valley, etc. protected from the wind.

Light meter: A measuring instrument that uses a photo electric cell to indicate the intensity of light in a particular area.

Lime: A form of calcium obtained when limestone is heated; used as mortar, cement and fertilizer.

Loam: A soil that contains particles of sand, silt and clay.

Lux: A unit of measurement to describe the degree of light intensity over an area of 1 m^2.

Maximum-minimum thermometer: A thermometer that shows the highest and the lowest temperatures at a particular place over a definite period of time.

Mini-climate: The weather and ecology of small areas or environments. It extends from about 1 m above the earth's surface to 25 cm beneath it in a particular area.

Observations: Whatever is perceived through the five senses: taste, touch, sight, smell, hearing.

Organism: A living thing that has cells and is fitted with organs vital to life.

Particles: A very little bit of something such as the individual bits of soil.

Pattern: The way in which something is arranged, such as the pattern of snow on either side of a snow fence.

Pellet: A small ball, e.g. when a raindrop falls into flour and hardens.

Percentage(%): The rate out of 100. e.g. The relative humidity of an area might be measured at 65%, meaning that the air in the area contains $\frac{65}{100}$ as much moisture as it could possibly contain.

Perpendicular position: Straight up or vertical; the line along which a mass suspended from a string lies at a right angle, or 90° angle to a surface.

pH paper: A type of chemically treated paper that changes colour to indicate whether a solution is acid, basic or neutral. A colour chart on the dispenser or vial shows values from 1 to 11 or other ranges. It can be purchased from a science supply house.

Photoelectric cell: A cell which is very sensitive to light and transfers the light intensity into an electrical impulse. It is used to make the needle of a light meter work.

Photosynthesis: The process by which green (chlorophyll) plants produce food.

Physical properties: The observable and measurable characteristics of a substance which are used to tell one substance from another, such as mass, colour, smell, texture, volume, etc.

Plot of ground: An area that is marked off in some way to investigate something of interest.

Population: The number of plants or animals living in a particular place.

Porosity: The amount of open space in a quantity of rock or earth material.

Precautions: The steps that are taken before an act to exercise care so that the results are accurate.

Prediction: The estimation of a result before it happens by using past knowledge and information that has been collected to form reasonable assumptions. Predictions should be tested.

Protractor: An instrument used to measure angles.

Raindrop collectors: A device used to collect raindrops. For construction see page 30.

Rain gauge: An instrument that measures the amount of rainfall. For construction see page 26.

Range: The limits within which something might be found.

Ravine: A hollow valley or gorge worn down by a stream.

Readings: The quantity that the scale of a measuring device registers and that is recorded during an investigation.

Reflection: The bouncing back of light rays from a surface.

Relative humidity: The amount of water vapour in the air compared to the total amount that the air could hold at its present temperature. It is expressed as a percentage.

Research station: An area set aside on or near a study plot at which materials and instruments are kept during an investigation.

Revolution: One complete turn, revolutions per minute (r/min), a unit of measure for speed; the number of complete turns in a certain period of time; e.g. The cup anemometer registered 46 r/min.

Scale: Graduations that are marked on a measuring device at regular intervals in units of measure.

Separator: A device used to separate invertebrate animals from leaf and soil litter. For construction see page 72.

Sifting frames: Cardboard or wooden frames containing meshed screening such as 15 mm and 10 mm hardware cloth, 5 mm and 3 mm screening and nylon stockings and used to sift and classify soil particles according to size. For construction see photo page 64.

Silt: A type of soil that is very fine and is usually found as sediment deposited by running or standing water.

Slope: The slanted or inclined surface of a mass of material.

Snake rolls: Soil moistened and rolled between the palms of one's hands for classification purposes.

Soil: The disintegrated rock material on the surface of the earth's crust. It is the material from which many plants and animals receive nutrition.

Solution: The result from dissolving a material in a liquid such as water.

Splash pillars: A device that can be made to measure the force of raindrops For construction see page 28.

Standardized readings: Readings from measuring devices that are adjusted before or after use to allow for inconsistencies in the instruments. For standardized thermometers see page 2.

Stomata: The pores on the leaves of a plant through which respiration and transpiration takes place.

Table: A chart of data or information collected during an investigation.

Temperature: The hotness or coldness of a substance measured with a thermometer in degrees Celsius (°C).

Tempera powder: Powdered paint that mixes with water. It is used for many art lessons.

Theory: An explanation that attempts to account for the cause of events in nature, to explain how events happen.

Thermometer stand: A device that enables temperatures to be taken at different heights above the ground in a mini-climate.

Transpiration: The process by which plants give off water vapour through the stomata of their leaves.

Trials: In taking measurements during investigations, several trials or tests are made and the results are averaged for better accuracy.

Typical area: When a plot is chosen in which a problem is to be investigated, it should be representative or very similar in vegetation, soil, moisture, protection from surrounding objects, slope, etc. to the whole area that is being studied.

Uniform: Remaining constant or the same in each test.

Variable: While investigating a problem one factor is changed or varied during the tests to see how it affects the results and the other factors remain constant or the same.

Vegetation: Plant life.

Vertical position: See perpendicular position.

Volume: The amount of space that an object takes up, measured in cubic units: cubic centimetres, decimetres or metres, etc.).

Water table: The upper boundary of ground water below which all spaces among rock and soil are completely filled with water and above which water seeps to the water table. It is above the ground in the form of streams, lakes, oceans, etc.

Weather vane: See wind vane.

Wind chill factor: The degree by which wind appears to lower the air temperature. For the chart see page 51.

Wind gauge: An instrument used to measure wind velocity—see anemometer.

Wind vane: An instrument used with a compass to measure the direction from which the wind is blowing. For construction see page 55.

Wind velocity: The speed at which air moves, measured in km/h.

Index of Activities

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What temperature differences can be found in the air above the ground surface?

Activity 1 (a): *Page 6*

Repeat Activity 1 but take temperature readings at one-hour intervals starting at 08:00 and continuing for as long as it is practical. What is meant by the word "intervals"?

Activity 1 (b): *Page 7*

Repeat Activity 1 under the same conditions to measure the temperature of the air above the following: an asphalt playing surface, a meadow with high grass, a sand pit, bare ground, a tree shaded spot, a concrete sidewalk, a small puddle.

Activity 1 (c): *Page 7*

Repeat Activity 1 (a) measuring the air temperature above an asphalt playing surface, a meadow with high grass, a sand pit, bare ground, a tree shaded spot, a concrete sidewalk, a small puddle.

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Activity 2 (b): *Page 10*

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Activity 2 (c): *Page 11*

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MINI-CLIMATES

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DATE DUE SLIP

RETURN FEB 11 '94
DUE EDUC. APR 11 '94
RETURN APR 05 '94
DUE EDUC. OCT 16 '94
RETURN OCT 12 '94
DUE EDUC JAN 30 '95
RETURN JAN 26 '95
DUE EDUC MAR 18 '96
RETURN APR 12 '96
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EDUC FEB 22 '91
FEB 21 RETURN
DUE EDUC JAN 28 '89

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DUE EDUC. FEB 18 '94

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